MAY 1955

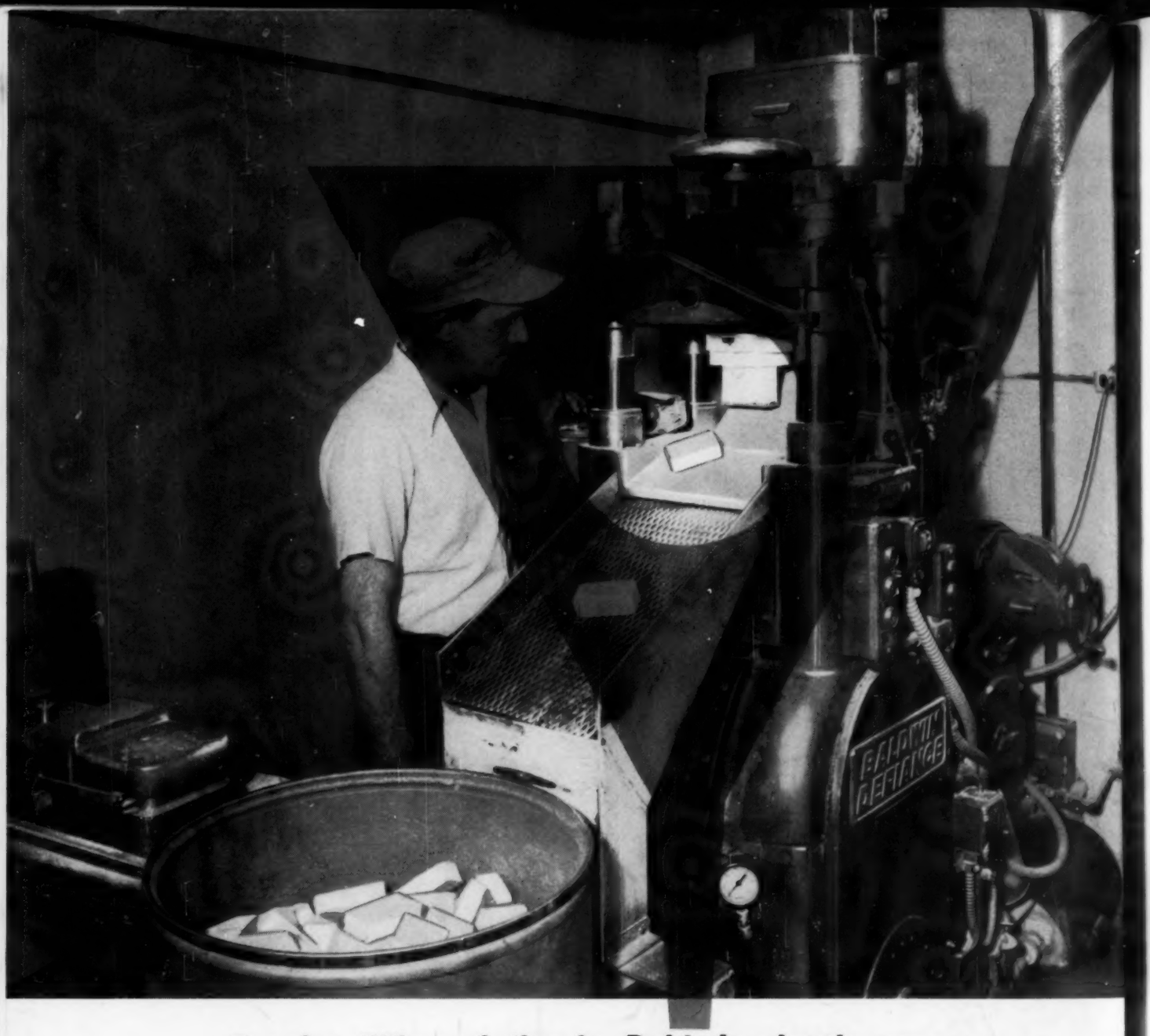
PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

A BILL BROTHERS PUBLICATION

NEW EPOXY RESINS, CURING SYSTEMS, AND APPLICATIONS

an article by Elliott N. Dorman/page 213



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Letters to the Editor

Dear Sir:

A great many people in this Division have commented favorably on the first two issues. Whether or not they have been impressed with the general format or the technical articles, I cannot as yet say, but the favorable comments have all been spontaneous and not solicited.

I was much impressed with the guest editorials in the first two issues. Both authors are to be complimented for the forthright manner in which their cases were presented. Every effort should be made to maintain the high quality already achieved with this feature.

The section, "Letters to the Editor," is certainly loaded with bouquets—and justifiably so. However, I get the general impression that many of the comments are from persons not too close to the technology of the industry. It is strongly suggested that you screen letters from engineering people and print those that offer constructive criticism. It would be a good idea periodically to print a letter which would be extremely critical of the magazine and answer it in this section. I feel that you would gain considerable stature in this way.

The papers in the February and March issues are of good quality. I particularly liked the one describing the Kreidl process and the paper on X-ray inspection methods. Bjorksten's lead-off article in the first issue was stimulating but a little on the "blue sky" side. The paper by Hendricks brings out some very useful information but I seem to recall a similar paper by him some two years ago. In addition, the paper has no bibliography.

I feel the magazine is off to a good start but that it would be well to critically re-evaluate what the objectives are and what need this publication is fulfilling in the plastics industry not already covered by magazines already well established in the trade.

C. Howard Adams, Research Dept., Plastics Div., Monsanto Chemical Co. Springfield, Massachusetts

(This letter is answered in the editorial on page 211 to which your attention is directed. Mr. Hendricks presented some data at the ACS meeting two years ago. This data was not published. This data and more modern information appeared in the Hendricks paper that was published in our March issue. As for the other magazines, we *are* different. But if we have forced them to improve their editorial content, then the industry has been the gainer.—Editor.)

• • •

Dear Sir:

I want to congratulate you on the first two issues of the new magazine, PLASTICS TECHNOLOGY, which I have read at our library in the chemistry department. Enclosed please find check for a personal subscription which I would like to have started with Vol. 1, No. 1, and sent to my home address.

George W. Blum, Assoc. Professor of Chem. Engr., Director, ASMPA Project Case Institute of Technology Cleveland, Ohio

• • •

Dear Sir:

I have read with interest and appreciation the first issues of your new publication, PLASTICS TECHNOLOGY.

I feel that you have given us a most readable and worthwhile publication, and I would like to offer my felicitations, both on the job you have done and the very favorable reception which it has enjoyed in the plastics industry.

John J. O'Connell, President Consolidated Molded Products Corp. Scranton, Pennsylvania

• • •

Dear Sir:

As a member of the Editorial Advisory Board, I am keenly interested in the magazine as a voice for the industry. By your fine issues you have fulfilled a definite need for presenting the technical aspects of the plastics industry while de-emphasizing the glamor, as we in the manufacturing end appreciate so well. With such splendid editorial leadership, I feel confident that your magazine will find ready acceptance in the field.

Harry T. Douglas Executive Vice President Lunn Laminates, Inc. Huntington Station, N. Y.

• • •

Dear Sir:

It has been brought to my attention that your new publication, PLASTICS TECHNOLOGY, is the best thing that

could have happened in the plastics field at this time.

Please enter my subscription beginning with Volume 1, No. 1 issued in February, 1955, and invoice me. Best regards.

Horace T. Bird, Manager
Kentucky Thermoplastic Co.
Elizabethtown, Kentucky

• • •

Dear Sir:

I have just received my second issue of your new publication. After going through two issues, I am convinced you will have a successful future. Belated but sincere best wishes!

James S. Lunn, President
Lunn Laminates, Inc.
Huntington Station, N. Y.

• • •

Dear Sir:

I have noted with particular interest the listing of current market prices on page 125 (Mar. issue). Although I am not sure as to what products are listed here, I am wondering if only price reductions or increases are included.

Regardless of your objective, I am enclosing a copy of our current price list on plasticizers and ask that this be included some time in the near future.

If it is not possible to include our prices, would you please give me an explanation of the general purpose of this price listing.

William E. Rau
Organic Chemicals Div.,
Monsanto Chemical Corp.
St. Louis, Missouri

(The full market price list appears quarterly; it was in the April issue and will appear again in July. Interim issues carry a listing of price changes and additions only, which explains Mr. Rau's question. The plasticizer prices mentioned have been added, and will be included in all future listings. All suppliers are invited to submit quotations on their products for inclusion in the price listing.—Editor.)

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation, and address.

Letters requesting information on technical or engineering problems will be printed to elicit replies by the readers, either directly or through these columns. Upon request, the identities of such "problem" letters will not be divulged.

—The Editor

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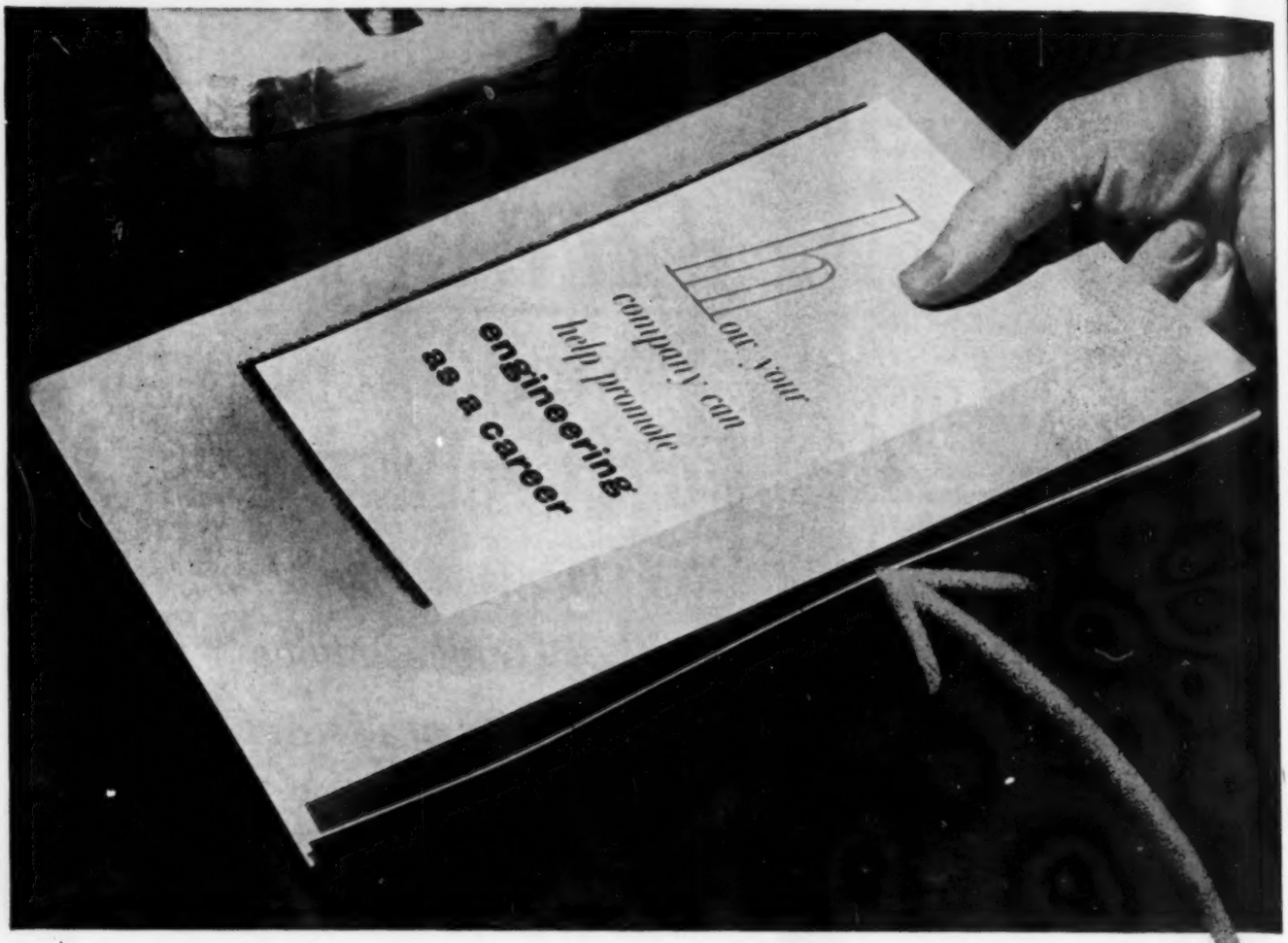

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NEWS in BRIEF

New facilities in plastics continue to be announced. A new plant to supply polyethylene producers with pigment and carbon black dispersions was opened in Orange, Tex., by Acheson Dispersed Pigments. Special facilities for products in medium-scale demand were installed by American Cyanamid at the firm's Bound Brook and Warners, N. J., plants. A lab for plastics packaging research on practical problems was opened by Bakelite at Bound Brook to concentrate on Krene film and the development of new products.

Along the same vein, Du Pont will construct a new lab at Chestnut Run, Del., for its fluorinated hydrocarbons. This lab is scheduled for completion early next year. A new plant to make diallyl phthalate prepolymers will be built by Ohio-Apex at Nitro, W. Va. A new firm, Plumb Chemical, has entered the plastics industry, and will make glass-reinforced molding compounds. Thiokol has reopened its Moss Point, N. J., plant to meet the growing demand for polysulfide liquid polymer.

Plastic tooling saves money, Chrysler reports. A $60,000 labor saving alone was shown by just one phase of the plastic tooling program undertaken by the firm's automotive body division.

Product quality is the prime factor if rigid polyvinyl chloride is to be used for corrosion resistance, according to John Bolten, Jr., in a guest editorial (see page 222). This quality can be controlled by stringent processing conditions and alert personnel. The young rigid PVC industry must educate its suppliers, converters, fabricators, distributors, and customers if the potentials of this material for anti-corrosion are to be realized.

A fiftieth anniversary is being celebrated by Hooker this year. The firm made a modest entry into the chemical field, diversified its products as it grew, and finally expanded into plastics. With the now-completed incorporation of Durez as a division, Hooker has strengthened its position in the field of plastics as a materials supplier.

Plastics abroad are of interest to domestic companies. Discussions of the current status of plastics in Great Britain, Canada, Japan, Norway, and Austria appear in the "News from Abroad" department in this issue.

Shocking news during the month was the sudden and accidental death of Norman J. Elder, vice president and manager of the calender division of Adamson-United, and a member of our Editorial Advisory Board to cover the field of calendering. Mr. Elder's name is being kept on the masthead of this issue. The vacancy on our Board will be filled in time for June by another authority on plastics calendering from the industry.

New materials of interest this month (see page 248) include: a nylon molding compound; polyethylene molding materials; glass-modified phenolic resins; a vinyl plastisol; mixed sebacic acid plasticizers; and an auxiliary stabilizer.

New equipment in the news (see page 250): standardized aluminum inserts for moldings; a semi-automatic embossing machine; a film slitter and rewinder; a dual-recording electronic potentiometer; stainless steel clamps for plastic pipe; and a series of temperature controllers.

New products worthy of mention (see page 253) include: butyrate frame strips for pictures; soldering guns with phenolic housings; vinyl diaphragm valves; triple-laminated vinyl fabric; an anti-corrosive tape with a polyethylene base; epoxy-fiberglass metal patches for autos; textile-resin filler material; simulated leather with a vinyl coating; peelable polyethylene adhesive for labels; and a series of polyester laminates.

Readers' Service Cards make their bow in this issue in response to many requests. To be a standard feature of the magazine, the cards provide a simple method for the reader to obtain more information on items described in New Materials, New Equipment, and New Products, and copies of publications mentioned in New Literature. These cards are for you—use them!

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PLASTICS TECHNOLOGY

MAY, 1955

EDITORIAL: The Magazine and its Readers

As its name implies, PLASTICS TECHNOLOGY is a technical magazine about plastics at the practical engineering level. It is aimed essentially at the processing industry, and tries to provide sound technical information that will be of value to plastics engineers in their daily problems. The growth to date of plastics is dwarfed by their potential application as true engineering materials, and the use of plastics in these applications awaits only the accumulation of the necessary engineering data. It is to the dissemination of such data that the magazine is dedicated.

•

In its current form, the magazine embodies the suggestions of technologists in the industry as to the type of technical magazine they themselves want. Every department and article subject is what is wanted. These suggestions have been and are still being received in surveys and in letters.

At the same time, we realize that there is need for constant improvement. For that reason we continually invite letters suggesting changes or other constructive criticism that we can use to improve the magazine. The letter from Howard Adams which appears in "Letters to the Editor" in this issue is a case in point, since he is a member of our Editorial Advisory Board. The letters which have been printed in each issue are not screened for content, and are as-received in the order of receipt. Our mail has been very good—actually too good, since not one really adverse criticism has been received. Frankly, we do not think the magazine is that perfect. It will be good within the near future when the industry understands and accepts what we are trying to do, and cooperates with us in furnishing the type of information desired. We will not stand still but will strive to improve farther and farther within the framework of comments received from our readers.

We ask the readers to tell us what article subjects they want, which departments we should add or expand, and which departments we should drop. It is *their* magazine and *they must tell us what they want in it.*

•

The format expresses our efforts to present the subject matter as interestingly, concisely, and factually as possible. It is still being changed as we experiment to find the best medium. For example, our cover color is the fourth in the original cycle of four colors —green, red, blue, and brown. Do you want a color cycle and, if so, do you want the four colors we have used? Or do you prefer that we standardize on one color and, if so, what color shall we use? Your comments are requested since this is *your* magazine and you must decide its appearance and contents.

Arthur M. Merrill

Editor

Developments in recent years have resulted in commercial bottle making machines using polyethylene materials with production methods based on the extrusion or injection moulding technique combined with the blowing process.

The Shipton Semi-Automatic Machine was designed for the smaller manufacturer who is likely to encounter a large number of medium-sized orders for different types and sizes of bottles.

The machine cycle is arranged to produce two types of bottles simultaneously in all sizes up to 2,300 cm.

The operator can work continuously between the two moulds provided the average wall thickness of the bottle does not exceed approximately 1mm. There is no waiting time for cooling off.

Both the automatic machine, illustrated above, and the semi-automatic machine are self-contained units which need only be connected with electrical and cooling water supplies for immediate production.

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Recent Advances in Epoxy Resins

A comprehensive discussion of the resins, their curing systems, and industrial applications.

ELLIOTT N. DORMAN, *Technical Sales Engineer*
Ciba Company, Inc., New York, N. Y.

Tremendous strides have been made since epoxy resins made their initial appearance on the American market in the mid-1940's. In this relatively short time, we have seen the advancement from amine-cured epoxy solutions of low heat distortion points to modern acid-cured, low viscosity liquid resins with heat distortion points in excess of 185° C.

Epoxy resins (also called epi-, epoxide, and ethoxyline resins) are the condensation products of epichlorohydrin with diphenols, such as "Bis phenol A", and have the structure shown in Figure 1. The resins, in the illustrated uncured state, are thermoplastic and range from low viscosity liquids ($n = 0$) to high melting point brittle solids ($n = 10$). An epoxy resin may be defined as a polyether containing a highly reactive epoxy or oxirane group at each terminal, separated by an alternating aromatic and aliphatic system containing hydroxyl groups.

Chemistry of Hardening

The epoxide group behaves as a highly unsaturated system and, therefore, can react by addition with a large number of different materials, especially those containing polar (active hydrogen) groups. Hence, except for being much more reactive, the epoxy group acts in a manner very similar to that of an olefin. However, in spite of their reactivity, they are not subject to air inhibition or catalysis and, therefore, offer exceptionally long storage lives and consistent curing or hardening characteristics.

Hardening of an epoxy resin is accomplished by reaction with a curing agent at room or elevated temperatures. Amines, acids, and other resins are the hardeners most commonly employed.

The reaction, when using an amine, involves the opening of the oxide to form an alcohol, without the formation of by-products. This leaves the hydroxyl group available for further reaction. Cross-linking is achieved when di-, tri-, and other polyamines are employed.

When acids, generally in the form of anhydrides, are used, the reaction probably occurs in two stages. Thus, both functional groups take part in the reaction and for each anhydride molecule consumed, an hydroxyl group is reformed and one epoxy group is consumed. Hence, acid curing yields a more fully cross-linked, tridimensional structure than is possible with amine-type curing agents.

In addition to these hardening systems, epoxides will polymerize with each other in the presence of suitable activators. It is quite apparent, therefore, that very many cross-linking possibilities are presented.

Photo by Louis McQuaid

Elliott N. Dorman received a B.S. in chemical engineering from Columbia University in 1949. He attended Syracuse University's College of Applied Science prior to entering the U. S. Navy. He served as sales engineer for Catalin Corp. of America, and has held his present position as technical sales engineer with the plastics division of Ciba Co., Inc., since 1950.

Mr. Dorman has presented and published several papers on epoxy resins. He is active in ASTM, ASTE, SPE, and various local technical groups. He has worked with product development and technical service for adhesive, electrical, laminating, and tooling applications of epoxies.

Since the hardener and resin actually react and the curing agent is molecularly combined, the properties of the final product are greatly influenced by the chemical structure of the hardener chosen. The reaction or hardening may therefore properly be termed polymetathesis, although only one product is formed.

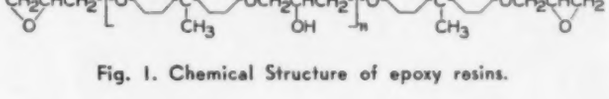

Fig. 1. Chemical Structure of epoxy resins.

General Properties

Epoxy resins owe their rapid rise and wide versatility to the following interesting properties:

(1) Wetting of and adhesion to a wide variety of different types of surfaces due to the presence of both hydrocarbon and polar centers in the molecule. (See Figure 2.)

(2) Curing without the evolution of by-products, permitting the manufacture of relatively bubble-free castings of all sizes.

(3) Very low volume shrinkage, due to the highly associated nature of the uncured resin which minimizes shrinkage strains set up during curing.

(4) Resistance to many acids, most alkalies, and solvents due to presence of highly stable ether linkages.

(5) High mechanical strengths.

(6) Good thermal stability.

(7) Outstanding electrical properties at both room and elevated temperatures.

(8) Exceptional water resistance.

(9) Practically complete resistance to fungi.

(10) Easy curing, with no need for special conditions or precise temperatures.

Resins Available

Very many epoxy resin-hardener systems and their modifications are currently available. These systems and their modifications are utilized as bonding, casting, coating, embedding, encapsulating, impregnating, laminating, potting, and tooling materials. This discussion is limited to those basic systems where amine, acid (anhydride), and special resins are employed, omitting the esterified types now used only in coatings.

The basic epoxy resins available range from low viscosity (100% epoxy) types to high melting point solids. Molecular weights vary from about 300 where $n = 0$ (see Figure 1), to 3750 where $n = 10$. Epoxy values range from 0.25-4.25 equivalents per kilogram of resin. In general, casting applications utilize resins with epoxy values greater than 2.25, whereas modified coatings are based on resins with values from 0.25-2.0.

Curing Systems

Liquid Amines

Typical room-temperature amine curing systems utilize materials such as triethylene tetramine for cross-linking. These systems have pot lives (working time after hardener has been added) ranging from 15 minutes to 1½ hours.

Fig. 2. Spreading epoxy resin adhesive on metal surface to be bonded to laminate.

The hardener, a liquid of low viscosity, is added to the liquid epoxy resin just prior to use. As the hardener is added, the viscosity decreases, the mixture starts warming up, and then thickens as the gel state is approached. The exotherm developed by a given system is dependent upon several variables: (1) mass of resin and hardener; (2) proportion of hardener added; (3) container material and geometry; and (4) ambient conditions.

A system such as just described is best illustrated by Araldite 502[1] resin and Araldite HN-951[1] hardener. The resin and hardener have initial viscosities at 23° C. of approximately 3,500 and 15 cps., respectively. The system has an initial viscosity of about 1,500 cps. after mixing 10 parts, by weight, of hardener with 100 parts by weight, of resin. Pot life is approximately 40 minutes, and the maximum exotherm developed is approximately 150° C. for a one-pound mass starting at 23.0° C. Properties of the cured system are given in Table 1.

This system has found wide use in bonding, casting, laminating and tooling applications. The major limitation, typical of epoxy room-temperature curing systems, is that the heat distortion point is never greater than 180-200° F.

Solid Acid Anhydrides

Acid cured systems, using materials such as phthalic anhydride, generally require "hot melt" conditions because precipitation of the anhydride occurs below 60° C. Since this elevated temperature is required, the advantages of a higher molecular weight (solid) resin, with a melting point higher than 60° C., can be realized.

[1]Product of Ciba Co., Inc., New York, N. Y.

The viscosities and pot lives of these systems at the handling temperatures are most satisfactory. Further, these systems are not hampered by high exotherms, exhibit excellent thermal stability, and have higher heat distortion points in addition to the usual epoxy properties.

Typical of this system is Araldite 6060[1], a low molecular weight solid epoxy resin, cured with Araldite HN-901[1]. The resin is heated to 120-130° C. and the hardener (30% of the resin weight) is added in its entirety. A low viscosity solution results which exhibits a pot life of over 1½ hours. No exotherms are developed and curing takes place above 90° C., with curing time dependent on the temperature employed.

The cured product exhibits a heat distortion point of approximately 110° C., in addition to excellent thermal stability. A weight loss of only 1.5% is noted after seven days' aging at 200° C. Other properties for the cured product are given in Table 2.

Table 1. Properties of Cured Araldite 502/HN-951 System

Tensile strength, psi.	8,000-9,000
Compressive strength, psi.	16,000-18,000
Flexural strength, psi.	14,000-15,000
Impact strength, Izod, ft.-lbs./in. of notch	0.39
Modulus of elasticity in tension, psi.	0.45×10^6
Coefficient of linear thermal expansion per °C.	9.0×10^{-5}
Hardness, Rockwell "M"	81-83
Water absorption after 24-hr. immersion, %	0.12-0.13
Specific gravity	1.15-1.20
Dielectric strength (short time), ⅛-in. section, volts/mil.	500
Surface resistivity, ohms	$>5.7 \times 10^{12}$
Volume resistivity, ohm-cm	$>8.0 \times 10^{13}$
Dielectric constant:	
60 cycles	4.11
10^6 cycles	3.80
Power factor:	
60 cycles	0.002
10^6 cycles	0.02

Table 2. Properties of Cured Araldite 6060/HN-901 System

Tensile strength, psi.	11,500-12,500
Compressive strength, psi.	15,000-16,000
Flexural strength, psi.	18,000-19,000
Impact strength, Izod, ft.-lbs./in. of notch	0.70
Modulus of elasticity in tension, psi.	0.45×10^6
Coefficient of linear thermal expansion per °C.	4.8×10^5
Hardness, Rockwell "M"	100
Water absorption after 24-hr. immersion, %	0.08
Dielectric strength (short time), ⅛-in. section, volts/mil.	400-410
Surface resistivity, ohms	$>5.7 \times 10^{12}$
Volume resistivity, ohm-cm	$>8.0 \times 10^{13}$
Dielectric constant:	
60 cycles	3.89
10^6 cycles	3.50
Power factor:	
60 cycles	0.0012
10^6 cycles	0.026

The two systems just briefly described illustrate the epoxy resin-hardener types in widest use today. Although each system has certain disadvantages, both have helped fill the wide gaps that exist in the resin field.

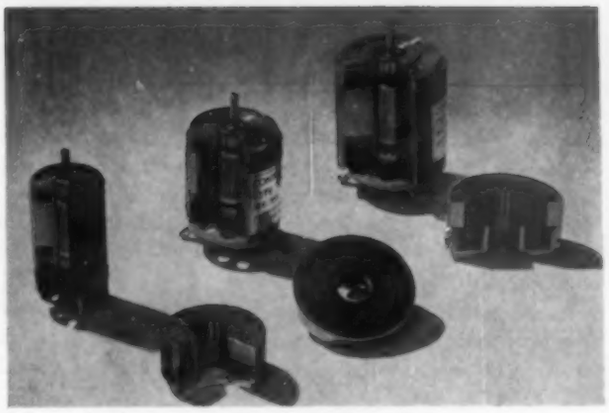

Fig. 3. Cut-away views of servo motors whose coils are embedded in epoxy resin.

Many variations are available. Diluents, plasticizers, solvents, fillers, pigments, dyes, etc., are employed to modify these systems. Further changes may be made by varying both the epoxy resin (epoxy value, viscosity, hydroxyl value, etc.) and the amine (e.g., diethylene triamine, triethylene tetramine, tetraethylene pentamine, etc.) or acid (e.g., phthalic anhydride, maleic anhydride, etc.). Hence, although basically only two systems have been discussed, very many different products can be produced to meet a wide variety of specifications.

Newer Hardeners

Endeavors by epoxy resin producers to overcome the limitations imposed by current types have resulted in newer resins and hardeners. Today, we have high heat distortion point systems; liquid acid hardeners, permitting room temperature handling; resilient, internally plasticized materials; short cure-time materials with long pot lives; and others.

Solid Aromatic Amines

Early in 1954, a new hardener for epoxies made its appearance. This material, metaphenylene diamine (MPDA)[2], is a solid aromatic amine which yields heat distortion points of about 150° C.

MPDA is generally used with the liquid epoxies (e.g., Araldite 6020) in quantities of 15% by weight of the resin being employed. Since this hardener is a solid, either of two mixing procedures is commonly used: (1) the crystalline MPDA is added directly to the heated epoxy and thoroughly mixed; or (2) the resin and MPDA are heated separately and then thoroughly mixed. The mixture can then be cast or used in the manufacture of glass laminates. Another important advantage offered by this system is the gel stage ("B stage") through which it passes in the process of curing. This permits "dry lay-up" techniques in laminating, and "two-stage" casting. This latter technique permits the minimizing of the high exothermic temperatures developed in large castings.

[2]Made by E. I. du Pont de Nemours & Co., Wilmington, Del.; General Aniline & Film Corp., New York, N. Y.; and National Aniline Div., Allied Chemical & Dye Corp., New York, N. Y.

As with any resin system, disadvantages exist. Those inherent in the MPDA system are as follows:

(1) It is necessary to maintain close temperature controls when heating MPDA to prevent excessive fuming.

(2) MPDA badly stains the skin and clothing, and should be handled very carefully. Further, its toxicological properties are really not completely known.

(3) The system must be post-cured at elevated temperatures (e.g., 350° F. for one hour) in order to achieve high heat distortion points.

(4) Although high distortion points can be realized, the resulting cured system has poor thermal stability and exhibits excessive weight loss upon aging at 150-200° C. aging.

(5) Mechanical properties are relatively poor, and include high coefficient of linear thermal expansion (in its useful temperature range), low compressive strength, low impact strength, and poor low temperature resistance.

Despite these disadvantages, the MPDA system should not be overlooked since it does offer what has been heretofore impossible in an amine system—high heat distortion points and "gel-stage" handling.

Liquid Acid Anhydrides

The next system to appear attempted to overcome the disadvantages of the early acid-cured types. The result was a liquid acid hardener, Epocast Type III[3], which, when combined with a liquid epoxy, possessed the following five characteristics:

(1) Low initial viscosity (1,500 cps. at 23° C.).

(2) Long pot life (up to 27 days).

(3) Relatively high heat distortion point (220° F.).

(4) Ability to cure readily at 150-200° F.

(5) Excellent physical and electrical properties.

This system is still unique among epoxies because of a third component (accelerator or promoter) with which the curing could be speeded up from 8 hours at 300° F. to as short as 50 minutes at only 150° F. It has found wide use in impregnating (exhibiting a viscosity as low as 100 cps. at 100° C.), laminating, tooling, and casting.

Complex Anhydrides

The latest hardening material to make its appearance is hexachloroendomethylene tetrahydro phthalic anhydride, commercially available as HET Anhydride[4] and Chlorendic Anhydride[5]. This material is a dicarboxylic anhydride, similar to phthalic anhydride, but offers several advantages over the latter because of higher heat distortion points, faster curing, greater hardness, and self-extinguishing property.

HET is handled very similarly to phthalic anhydride; the hardener is dissolved in the heated resin 120° C. with vigorous stirring. A liquid epoxy (e.g. Araldite 6020) is generally employed with equal parts, by weight, of HET. The resulting mixture exhibits a low viscosity and a pot life of about 30 minutes.

As with most other systems, the heat distortion point of the cured resin is dependent upon the conditions of curing. It is interesting to observe how these conditions affect the distortion points, as shown in Table 3.

Table 3. Heat Distortion Points of Araldite 6020 Resin/ HET Anhydride (1:1) System

	Distortion Point, °C., When Cured for			
Curing Temp., °C.	2 Hrs.	4 Hrs.	8 Hrs.	24 Hrs.
120	97	113	131	144
140	129	148	155	168
160	153	169	173	182
180	170	177	182	187

Aside from thermal properties, this system's characteristics are very similar to those of a phthalic anhydride (pa) cured type. Both systems display excellent thermal stability, as shown by weight losses upon elevated temperature aging:

	Weight Loss on Aging, %	
	Araldite 6020 & HET	Araldite 6020 & pa
7 days at 200° C.	0.7	1.5
30 days at 200° C.	4.0	2.7

Liquid Polysulfides

The systems previously described yield relatively hard cured products. It is possible, by employing relatively long chain hardeners, to obtain resilient products. One such cross-linking type is Thiokol[6].

Several Thiokol liquid polymers are available which vary in viscosity, molecular weight, and degree of cross-linking in increasing order: LP-38, LP-8, LP-33, LP-31, LP-32 and LP-2. These materials are employed, in conjunction with liquid amines, in amounts up to 200% of the epoxy resin weight. The desired polysulfide and liquid amine are usually mixed together, and serve as the hardening component. Properties of some epoxy-polysulfide systems are given in Table 4.

Table 4. Compositions and Properties of Typical Epoxy-Polysulfide Systems

Composition, parts by weight:			
Araldite 6020 resin	100	100	100
Thiokol LP-3 liquid polysulfide	50	100	200
Araldite HN-951 amine	10	10	10
Properties:			
Viscosity at 80° F., cps.	1700	1700	1600
Pot life at 80° F., min.	15	25	70
Hardness, Shore D	95	80	75
Tensile strength, psi.	2850	600	325
Elongation, %	30	70	70

Liquid Polyamides

Another useful system utilizes liquid and semi-liquid Polyamide 100 and 115[7]. The epoxy and poly-

[3]Product of Furane Plastics, Inc., Los Angeles, Calif.
[4]Product of Hooker Electrochemical Co., Niagara Falls, N. Y.
[5]Product of Velsicol Corp., Chicago, Ill.
[6]Product of Thiokol Corp., Trenton, N. J.
[7]Products of General Mills, Inc., Minneapolis, Minn.

amide are generally blended by adding the warmed polyamide (50-60° C.) to the relatively fluid epoxy. Further reduction of viscosity can be achieved by slightly heating the mixture, resulting in shortened pot life.

Curing is accomplished at elevated temperatures (e.g., 20 minutes at 300° F.) with batch quantities less than 6-8 pounds. The cured products offer high impact resistance, outstanding adhesion, high dielectric strength, and excellent resistance to water and solvents.

The polyamides are employed generally in quantities from 40-100% of the epoxy weight. Increasing proportions of polyamide yielding products of higher impact strength and resiliency.

Applications

Adhesives

Epoxy resin based adhesives are being widely used in the bonding of a wide variety of materials. They exhibit specific adhesion to all materials including metals, ceramics, glass, plastics (except the halogenated and straight polyethylenes, silicone rubbers, and certain vinyls), and wood. Bond shear strengths in excess of 4,000 psi. have been realized. (See Figure 2.)

Casting

The rigid requirements recently being specified for electronic and electrical equipment have necessitated embedment, encapsulation, and potting in many cases. Epoxy resins are being used for the embedment of units ranging in size from transistors; capacitors; precision resistors; television components; servo; synchro and gyro motors; delay lines; to instrument transformers 12 feet high contained in 2,200 pounds of resin. (See Figure 3.)

Coatings

Perhaps the greatest variety of epoxy types is utilized in the surface coatings field. Hardening systems vary from

(Continued on page 236)

Fig. 4. Sequence of operations in hand lay-up of a boat made with glass mat and epoxy resin. Final photo shows cured boat being removed from the mold, and ready for trimming operations.

Production Preparation for New Compression Molds

How to plan and design accessory mold equipment so as to avoid delays in placing new molds into full production

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Getting prepared for delivery of new plastic molds is an important part of any scheduled production program. Many details must be attended to, and many precautions must be taken during the time that new molds are being constructed. Because compression molds for plastics are usually massive, and often quite complicated in their design, they require many weeks of a toolmaker's time.

The time taken to construct these dies, however, can be used to advantage by the planning engineer. The molding materials auxiliary loading equipment, heating requirements, mold insulation, and many other details should be worked out ahead of time. If these pre-production details are adequately taken care of, no delay will be encountered after the dies have been delivered.

Efficient planning is an important prerequisite to any production run, but this is especially true in instances where large presses and dies are involved. As a rule, a promise made for the delivery of finished moldings is based on the number of weeks promised for delivery of the mold. Shipments of moldings are then expected to be made in accordance with these predetermined estimates. So much attention is focused on actual production procedure that other less evident factors are very often overlooked.

Materials

If orders for new compression molds have been placed, then the materials should be in the plant and ready to run just as soon as possible. The amount and type of material are functions of production requirements. Coincident with authorization for construction of new molds should be the placement of orders for the materials. Then if bulk powder is to be used, the material will be on hand when the dies arrive.

For standard compression molding, phenolics, ureas, and melamines are the materials most generally used. These compounds are usually supplied in 50-lb. bags or 200-300 pound drums. Inasmuch as the materials are not always molded immediately upon their arrival at the molding plant, it is important that they be stored in a cool dry room.

Needless to say, sufficient space should be allowed for easy handling of the material and ready availability just as soon as the mold is delivered. If preforms are to be used, then conversion should be made at the earliest possible time. Molding compounds of any kind should not be stored too long, and it is good practice to use them just as soon as production conditions will permit.

Loading Board and Mold Relationship

The capacity of a mold is usually expressed in the number of cavities it contains and capacity is determined primarily on the basis of production requirements. Once the required number of cavities has been established, then the relationship of mold dimensions to press capacity must be considered. In other words, available pressures are considered, and then the actual mold size calculated in order to adapt the mold to the type of press to be used.

When these two considerations have been satisfied, it is generally deemed sufficient to proceed with construction of the mold. There is, though, another very important factor that should be given serious thought. If the part to be molded requires the use of powder instead of preforms, the design of the

device used to load the cavities must share in the final design analysis.

Any type of loading device is far less expensive than the multiple-cavity compression mold, but an important relationship exists between the loading board and its respective die. In fact, it is possible to construct a die in a manner that will prevent the use of a loading board. Correlation of mold design and loading device construction at the outset is, therefore, of utmost importance.

This relationship can best be shown by investigating a typical example. In Figure 1 is shown a rectangular-shaped piece, similar to an ordinary piano sharp, which is four inches long, ½-inch wide, and one inch deep. The part has to be molded so that the thick section is the depth dimension because of the grooving on both top and bottom. Let us assume that fairly large quantities of the piece are wanted, and that the material is a phenolic powder with a bulk factor of 4:1.

In order to bring out the point, it is necessary to reject certain suggestions that immediately come to mind, such as the use of preforms, plunger molding, high frequency heating, and other alternative methods of molding. Figure 2 shows the proposed mold with the rectangular pieces placed in position vertical to the front of the die. As can be seen, the mold has a width dimension of 12 inches, and with a length of 18 inches can accommodate 28 cavities.

Looking at the proposed mold construction from the standpoint of press adaptability and production requirements, there is apparently nothing to criticize. Four sets of knockout pins could be used to eject the pieces; the bars being spaced approximately four inches apart, and the pins mounted on one-inch centers. Insofar as over-all die dimensions are concerned, an 18 x 12-inch mold will adequately fit into a medium sized press and, on the basis of a four-minute cycle, the assumed requirements of 25,000 pieces per week can be easily fulfilled.

So from all appearances the mold design seems correct. Unfortunately, the method of loading has not been considered seriously. Obviously, the weighing of individual charges for the 28 cavities will not be acceptable. Instead, a loading board must be designed which will automatically release the correct amount of powder for the entire mold. This means volumetric loading and, hence, the size of each recess in the board must be determined for length, width, and depth.

Loading Board Construction

The method used for ascertaining the receptacle size for any loading board constitutes three steps, as follows:

(1) Determine the desired volume of loose powder.

(2) Ascertain the maximum horizontal dimensions allowable.

(3) Divide the desired volume figure by the horizontal area.

Step 3 will provide the required thickness of the board, which should be kept at a minimum to make the loading device as light in weight as possible. Therefore, in Step 2 the horizontal dimensions must be made as large as is permissible. It is here that the design of the die enters into the planning sequence. As can be seen from Figure 1, the required volume can be calculated.

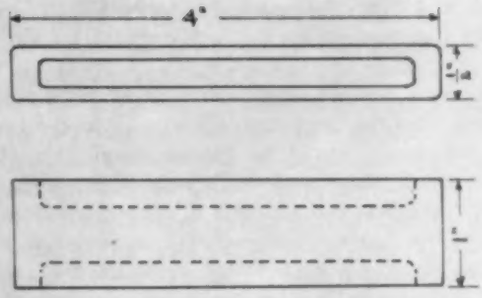

Fig. 1. Top and side views of typical part to be molded.

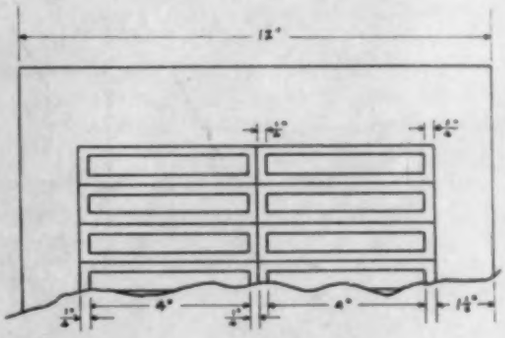

Fig. 2. Drawing of proposed mold to make part shown in Figure 1.

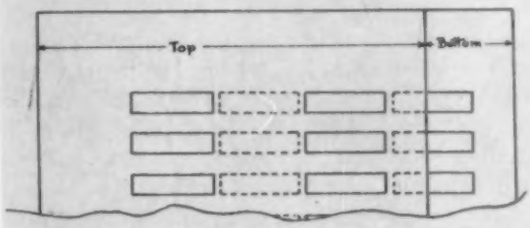

Fig. 3. Preliminary design of loading board: (left) board in loading position for filling of receptacles; and (right) board halves aligned to empty loads into mold cavities.

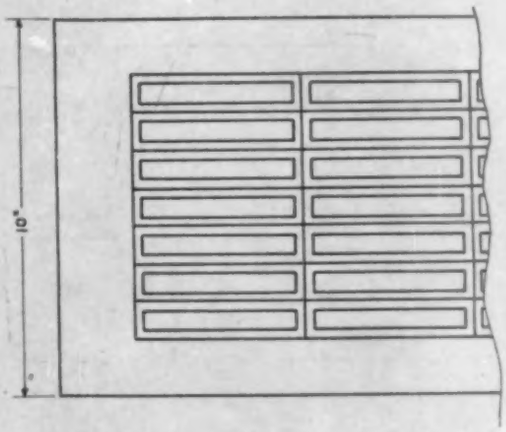

Fig. 4. Redesigned loading board of reduced thickness and weight.

From this, the required thickness of the loading board can be ascertained if Steps 2 and 3 are followed.

The total volume of each piece is approximately 1½ cubic inches. Since the material has a bulk factor of 4:1, the total volume required for each receptacle is six cubic inches.

Under ordinary circumstances it would be reasonable to assume that the horizontal dimensions of the loading board receptacles could be the same as those of the cavities. If this were so here, it would be necessary to multiply four inches by ½-inch to get a horizontal area of two square inches. Then carrying out Step 3, it would be found that the loading board should be three inches thick if it is to contain six cubic inches of volume. However, the mold has not been designed correctly for adaptation of this two-inch surface area, and the maximum receptacle length is less than two inches. Therefore, to contain six cubic inches the loading board would have to be over six inches deep. Of course, such depth is out of the question from a practical standpoint and some slower means, other than the use of loading board, would have to be devised.

The question naturally arises as to why a limitation of only two inches is placed on the length dimension. Reference to the drawings of the cut-away sections shown in Figure 3 will illustrate the answer. The left-hand drawing shows the board in the powder loading position, with the bottom half placed so as to permit filling of the receptacles. In the right-hand drawing, the lower half of the board has been pulled forward, thereby bringing the open spaces into register and permitting the load to empty into the respective cavities.

As can be seen, increasing the length of the holes will cause an overlapping of the top and bottom halves of the board. This will cause leakage of the molding compound when the board is in loading position. Hence, it is evident that consideration must be given to the horizontal dimensions of the receptacle size. The example cited also demonstrates how positioning of the cavities in the mold bears a distinct relationship to the construction of the loading board.

Since construction of a six-inch deep top board is impractical, the only way to rectify the condition is to redesign the mold. In order to facilitate more area for the loading spaces, the cavities would have to be spaced farther apart in the frame. Any such change would not only cost more, but also entail the use of a die with exaggerated over-all dimensions.

The solution is to be found, of course, in a directional rearrangement of the cavities. Instead of two rows of 14 cavities, the die should be made with seven rows of four cavities with the impressions at right angles to those shown in Figure 2. As indicated in Figure 4, this design would result in a die with over-all dimensions of 22 x 10 inches. The total area of the mold, therefore, would be 220 square inches as compared with the original area of 18 x 12 inches or 216 square inches. So for practically the same area, an entirely different cavity arrangement is made possible.

With an arrangement such as that shown in Figure 4, it becomes possible to increase the length dimension of each loading board receptacle from two to four inches, and thereby reduce the thickness proportionately. The loading board containers could now measure 4 x ½ x 3 inches. In other words, the thickness could be reduced 50% and the weight of the board cut in half. Aside from the economy realized in the actual construction of the loading device, the new design provides a much less cumbersome device from a production standpoint.

Making the Loading Board

Once the design of the loading device has been determined definitely, the actual construction of the equipment should begin. The finished loading board should be ready so that production can start when the new mold is delivered. As shown in Figure 5, other details, such as length of the knockout pins, mold insulation thickness, location of heating holes, etc., comprise a part of the general preliminaries. In order to build the loading board, however, it is necessary that concurrent procedures be followed.

The over-all size of the die must be known and the exact location of the guide-pin holes ascertained. Then the position of each cavity with relation to the outside of the frame must be outlined. The thickness of the board must be calculated and, as previously pointed out, this dimension is a function of the length and breadth

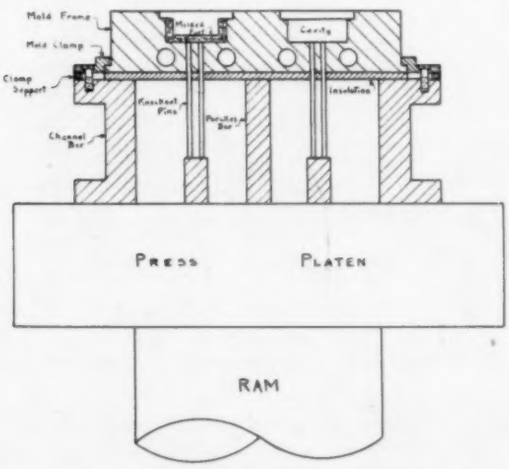

Fig. 5. Cross-sectional drawing of typical press installation for bottom half of a mold.

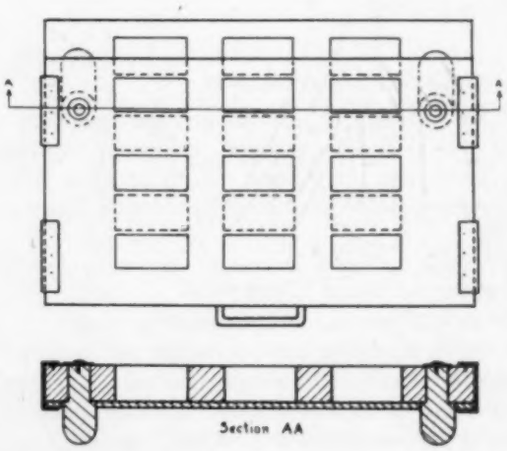

Fig. 6. Top and cross-sectional views of typical loading board construction.

of the receptacles. Calculating the correct size of each opening is merely a matter of computing the total cubical content and relating this figure to the three dimensions.

Loading boards are made in two parts. The top board is usually made of hardwood, although the lighter metals can be used on smaller dies. The choice of board material depends upon the weight that the operator must handle. The top action is, the part into which the molding compound is placed, so this upper board must be made accurately insofar as the receptacle size is concerned.

The bottom half of the loading device should be made as thin as is practicable in order to minimize the total weight. This section is used solely for the purpose of holding the material, and its holes must coincide in horizontal dimensions with those of the top board. If the two openings do not match, or there is imperfect alignment, then the molding powder will not empty when the bottom half is released.

When the board is in position for loading, the top openings are out of register with those of the bottom (see Figure 6). After the tray has been placed in position on the die, the bottom board is either pushed or pulled until the two series of openings come into register and the molding compound drops into each cavity.

Bulk factors of thermosetting materials vary widely; therefore, the type of powder to be used must be definitely decided upon prior to construction of the loading board. If it becomes necessary at some future time to use a material of a different specific volume, the operator will have to either add or take away small quantities of powder during the loading operation. When cups are utilized for powder loading, false bottoms in the cups permit a wider variation of volume because they can be adjusted in accordance with varying bulk factors.

Heating Media

During the past few years the use of electricity as a mold heating medium has increased in popularity. While steam is still used to a larger extent, electrical cartridges are replacing this method of heating in a number of instances. Molds cored for steam heating require no preliminary planning on the part of the plant engineer, but the use of electricity for heating molds entails many important calculations.

There are two types of electric heating elements now in use, and the choice depends chiefly upon the design of the mold. Flat strip heaters are installed when rectangular slots have been milled on the face of the mold. Cartridge type heating units are inserted into cored holes which are drilled in the upper and lower halves of the mold. Figure 5 illustrates a typical example of coring for the round cartridge units. Cartridge length should conform to that of the die frame, although a slight variation of ± 0.5 inch is allowable. Cartridge diameters are usually ¾ or one inch.

Electrical units are available in a wide variety of wattages, and the total heat required must be calculated as a function of the cubical contents of the mold. In order to compensate for radiation losses on the outer sections of the die, the cartridges of higher ratings are generally placed in the outside holes, as shown in Figure 7. For example, if the total wattage required amounted to 3.7 kilowatts and there were four holes in the die of Figure 7 instead of three, then the two outside units would probably have 950-watt ratings, and the inside cartridges would be rated at 900 watts. The cartridges themselves are constructed with a heat gradient so that they give off more heat on the ends than in the middle sections. Thus, a more uniform distribution of heat on the mold is made possible.

Since the cartridges should be ready for insertion into the mold just as soon as the die arrives, they should be specified correctly in all respects. This means that the cartridges must be of the correct length, and have the

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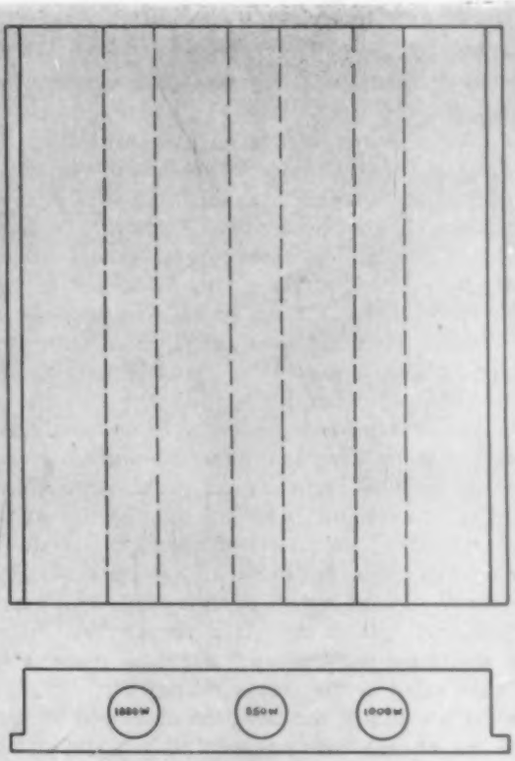


Fig. 7. Location of electric cartridges in heater plate

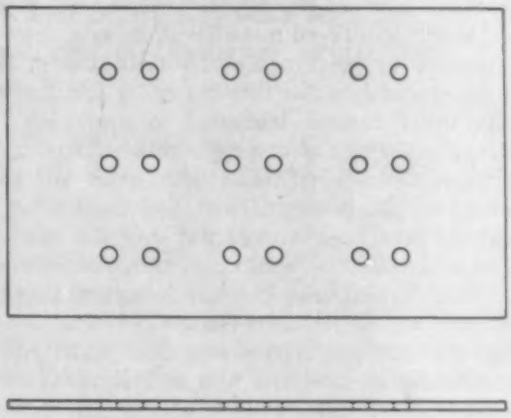
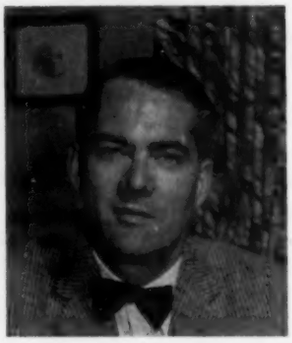


Fig. 8. Typical mold insulation board drilled for knockout pins



Guest Editorial

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Corrosion and Polyvinyl Chloride

One of the most interesting recent United States applications for PVC (polyvinyl chloride) resin has been in the field of corrosion protection.

It has been known for many years that unmodified PVC has astounding chemical resistance properties. However, in unmodified or pure state, the processing temperature of PVC is higher than its decomposition temperature. Thus, the basic problem has been to keep the vinyl molecule or compound as pure as possible and yet be able to process it.

Processing aids, therefore, must be chosen extremely carefully; many common ones destroy as much as 50% of some of the chemical properties even when added in amounts as small as 3%. In the past few years, much has been learned about proper stabilizer systems and great advances have been made in the technology of molding, sheet laminating, and extrusion of pipe, rod and tubing. As a result, PVC materials with optimum physical and chemical properties are available today to the corrosion engineer.

In the late 1930's, the Germans developed "Vinidur," based on an emulsion-polymerized and pre-stabilized vinyl. Because of shortages of stainless steel, nickel, lead, etc., the last war gave PVC in Germany a tremendous boost. However, superb performance proved this material was not just "ersatz" but, indeed, superior by test to the traditional materials in many respects.

A number of years ago, some European materials were introduced into this country, and a few American manufacturers became interested in producing them domestically. Vinyl for corrosion resistance requires a rather specialized vinyl resin with close control of molecular weight, polymerization, and many other factors which have been worked out over the years. We now have available a number of American-produced resins which are superior in some important properties to the emulsion-polymerized European resins.

Rigid PVC as a corrosion-resistant material must be used without plasticizer, and with an absolute minimum of stabilizers and lubricants. A compromise here will immediately effect the chemical resistance properties. There is a very thin hairline between the utmost in chemical properties on the one hand, and non-processability on the other hand. However, this line must be maintained for the success of this product, and can be controlled by very exact and stringent processing conditions, and alertness of manufacturing and supervisory personnel.

Quality and its consistency is the most important problem which this youngest branch of the vinyl industry faces. How this quality problem is handled during the coming year could very easily determine if PVC will find wide approval in the potentially tremendous corrosion resistance industry.

Unfortunately, a poorly made sheet, pipe, welding rod, fitting, etc., cannot be distinguished visually from a well-made one, any more than a poorly plasticized sheet with a highly volatile plasticizer system can be distinguished visually from the product of a reputable manufacturer. With PVC, however, the values involved are much higher and, secondly, there is a subsequent manufacturing process (namely, the fabrication, cementing, and welding of tanks, ducts, and other shapes) over which the manufacturer of the resin and the semi-fabricator have very little control.

The magnitude of this problem is perhaps best shown by an example. A manufacturer has installed a sulfuric acid handling system containing a tank which is made up of sheets that are welded together; a number of pipes going to and from the tank; valves that have been fabricated; and fittings that have been molded or fabricated. There must be no failures because of faulty material, fabrication, welding, construction, or design. If a failure occurs, it could easily be disastrous not only because of the monetary loss, but also from the point of safety as injury or death could result.

This young industry has a tremendous educational job ahead of it; education of its raw material suppliers, its converters, its fabricators, its distributors, and its customers. This program will require money, time, patience, and effort, but it will have to be done if this industry is to tap the huge potential that unquestionably exists. The advantages which PVC offers in the corrosion field could open up tremendous fields. The required volume could be fantastic if enough courage and intelligence are shown during these next few years in voluntarily policing the industry, and in maintaining the highest possible quality standard.

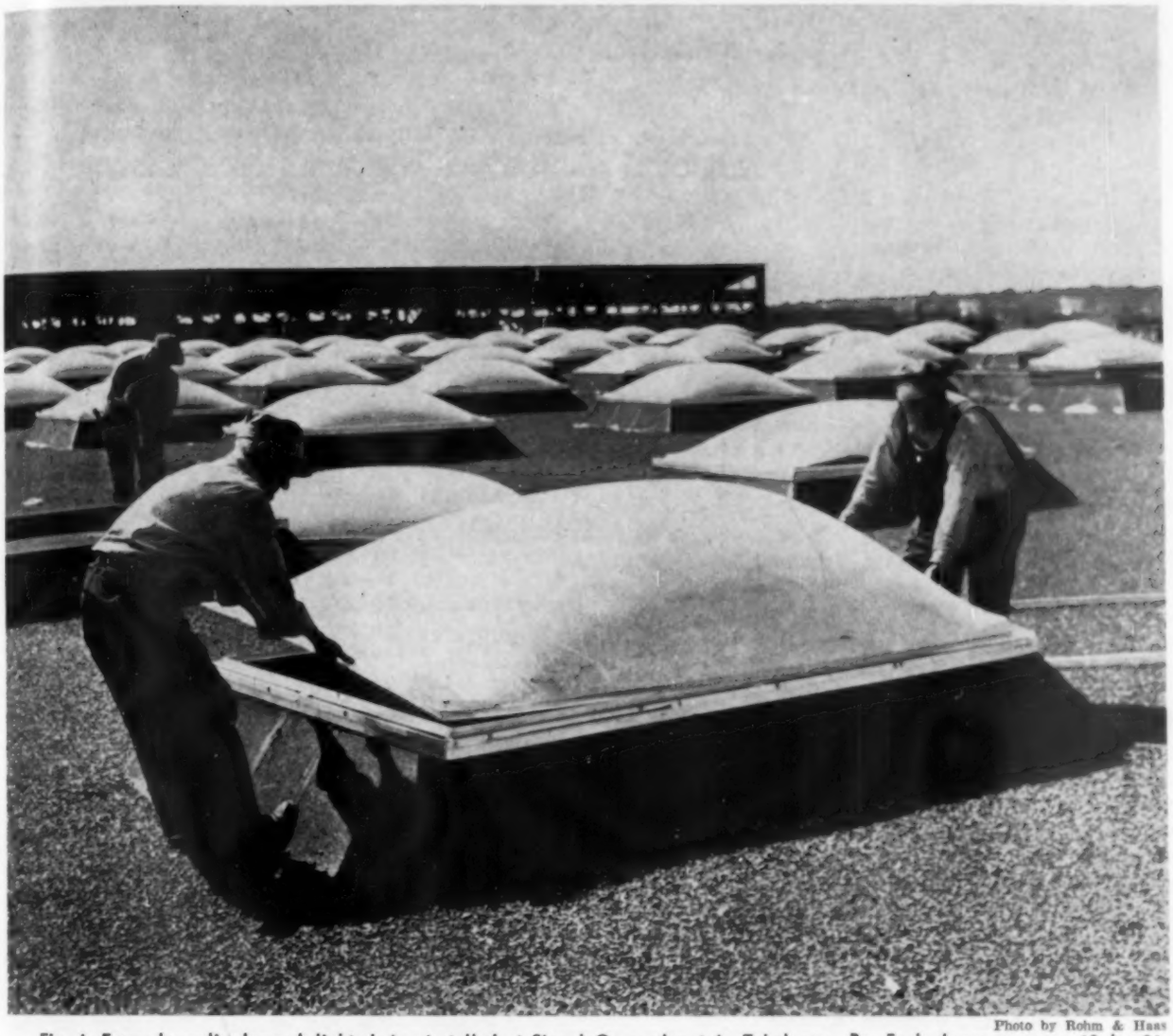

Photo by Rohm & Haas

Fig. 1. Formed acrylic dome skylights being installed at Signal Corps depot in Tobyhanna, Pa. Each dome measures 62 by 96 inches, and is formed from 0.312-inch thick acrylic sheet.

Plastics for Glazing and Illumination[1]

Light-transmitting acrylic, vinyl, and reinforced polyester plastics as used in glazing, luminous ceilings, and façades take full advantage of material properties.

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Light transmitting plastics are being used for a number of applications in the building industry in addition to light-transmitting panels. These panels have rapidly come into wide use since they could be substituted readily for opaque materials and often installed by the same methods. Other light-transmitting uses of plastics have required development of "packages" which can be specified by the architect and easily obtained and installed by the builder. Lighting fixtures are an elementary illustration of this type of plastics application, but are considered beyond the scope of this paper because they are so readily available, and installed normally as an accessory to the finished building.

The outstanding light-transmitting uses of plastics are in skylights, glazing, and luminous ceilings and façades. These applications also illustrate different stages in the development of plastics applications in the building industry. One-piece dome skylights have become very well

[1] Based on a paper presented at the "Plastics in Building" Conference of the Building Research Institute, Washington, D.C., Oct. 27, 1954.

Table I. Properties of Plastics for Light Transmitting Uses in Buildings

	Acrylic		Polyester	Vinyl
	Cast Sheet Heat resistant	Molding Powder Heat resistant	Reinforced with woven glass	General-purpose unfilled
Specific gravity	1.18-1.19	1.18-1.19	1.65-1.9	1.15-1.35
Luminous transmittance, %	91-92	91-92	———	———
Max. coefficient of thermal expansion, in./in./°C.	0.00009	0.00009	———	———
Flammability:				
Under 0.050-in. thick, sq.in./min.	———	———	———	0.04 (Self-Ext.)
Over 0.050-in. thick, in./min.	0.5-2.5	1.0 (1/4-in. thick)	0.5 (Self-Ext.)	0.02 (Self-Ext.)
Water absorption after 24 hrs., %	0.2-0.4	0.3	0.1-0.7	0.4-0.7
Effect of light	Slight	Slight	Slight	Eventually darkens
Max. recommended service temp., °F.	180-200	185	———	140
Impact strength (Izod notched), ft.-lbs./in.	0.4	0.5 (molded)	13-19 (edge)	———
Flexural stress at fracture, psi.	15,000-17,000	15,000-17,000	36,000-70,000	———
Modulus (apparent), psi.	400,000-500,000	450,000	2,000,000-3,500,000	———
Tensile stress at fracture, psi.	8,000-10,000	8,000-10,000	30,000-46,000	1,400-3,000

established and are available from a large number of manufacturers in packages ready for use. Window glazing ranges from the simple substitution of flat plastic panels for glass, to a number of ideas which are still under development where the other properties of plastics may be used to create new and attractive effects for control of daylighting. Luminous ceilings have also progressed to the package stage, but store fronts or façades remain largely a custom business.

Principal Plastics Used

Three basic types of plastics are used for glazing and illumination; acrylics, vinyls, and glass-reinforced polyesters. The general properties of these materials are shown in Table 1.

Acrylics

The outstanding properties of the acrylic plastics are excellent resistance to weather and great clarity. The weather resistance is demonstrated by the use of cast acrylic sheets for aircraft glazing, and by many years of satisfactory performance in the building industry. The water-white transparency of the basic material permits unusually high light transmission when used in the clear form. It also permits a full spectrum of colors ranging from neutral gray tints for glare control, to diffusing translucent colors of interest in ceilings, façades and some types of skylights. Special compositions of the acrylics can transmit more ultraviolet than normal glass glazing.

The material in the cast sheet form is available in truly construction industry sizes up to about 8 x 10 feet, and in thicknesses down to 1/16 inch. It is also available as a molding composition which may be converted to sheet form by extrusion, or to a wide variety of special shapes by injection molding. These latter uses are typified by automobile tail parking light lenses.

Being a thermoplastic, the material is readily formed into the useful shapes required for building. Thus, a dome skylight can be made from a flat cast sheet by simply heating the sheet, clamping it around the periphery, and blowing it to the required height. This thermoplastic property also leads to some limitations in use, but reference to Table 1 will show that the heat distortion temperatures or allowable service temperatures are sufficiently high for building use even in the tropics.

Like all of the organic plastics, the acrylics have relatively large coefficients of thermal expansion, so that installations require adequate provision for expansion and contraction of the plastic, particularly when used in very large sizes. In general, this creates no severe problems so long as the architect or builder is aware of this property.

The acrylics also offer good tensile, impact, and flexural strength properties, but overworking can cause crazing. Allowable working stresses for continuously imposed loads are in the range of 1500-2000 psi., but under many conditions such loads may result in an undesirably large deflection. Hence, the long-time deflection or cold flow of the material should be investigated. These problems are avoided normally by shaping the material, so as to satisfactorily rigidize it, as in corrugated sheet or dome skylights.

Vinyls

The vinyl plastics are generally not recommended for long term use in outdoor exposures. Their outstanding properties are an extreme toughness (which permits their use in very thin sections) and self-extinguishing

nature after ignition. Like the acrylics, the vinyls are thermoplastic and may be processed by the same general methods.

Production of very thin sheets, the most common form in which the material is used in buildings, is usually accomplished by calendering. The thin sheets are then corrugated to provide sufficient rigidity. Custom formed shapes may be readily produced. The vinyls are basically transparent, but are normally used in white translucent sheets to provide good diffusion of artificial illumination.

Reinforced Polyesters

Light transmitting polyester plastics are normally used with a fiberglass reinforcement. They are characterized by great strength derived from the glass reinforcement, and can be made in a variety of custom shapes and sizes. They offer good weather resistance with minor trouble from erosion exposing the glass reinforcement. At present the materials are not available in a completely transparent sheet; the glass introducing the translucent effect. The widest use of these materials is in the form of corrugated panels, but some custom shapes have been used, at least experimentally, in skylights, windows, and ceilings.

Applications

Skylights

The one-piece dome skylight is an outstanding example of the adaptability of plastics to the requirements of the building industry. This development dates back to 1946, but it has not been until recent years that the skylights have become widely used. They offer the advantage of a skylight enclosure which is entirely in one piece and, thus, leakproof. Since the units require no supporting frames, they admit substantially more light to the building through a given size of opening. Where

Photo by Rohm & Haas Company

O. L. Pierson

desirable, they may be made in a translucent acrylic sheet, thus diffusing the light more completely within the building.

Despite these outstanding advantages, development moved quite slowly until completely packaged units were made available by building supply people or fabricators. These units are now supplied to the trade with the flashing and edge attachment already mounted to the acrylic sheet. Their light weight usually permits one man to handle them during the installation, although some of the very large size domes (five by eight feet) require two men. Installation normally consists of dropping the unit over the prepared curbs and fastening it in place, thus effecting a substantial reduction in the amount of on-site labor required.

These dome skylights utilize some of the best properties of the acrylic plastics, i.e., weather resistance, transparency, shatter resistance, large size sheets, and formability. Some development work has been done on skylight domes of other plastics, principally polyesters, and a good many other shapes have been used or tested. For example, corrugated sheet have been used as a glazing material for custom built skylights ranging from nearly flat units to the steeply inclined glazing used in

Photo by Rohm & Haas Company

Fig. 2. Formed acrylic sheets used for passageway cover and dome skylight at S. C. Johnson Co., Racine, Wisc. Passageway cover sections were made from sheets 60 by 120 inches and 0.500-inch thick.

sawtooth construction. The acrylics, however, remain the principal material used for skylights, primarily because the sheet is readily formed to the desired shapes even on a custom basis, and offers all of the other properties necessary for a long-lived installation.

Figure 1 shows an installation of large size, commercially fabricated skylight domes nearing completion. It will be noted that the flashing and edge protection has been attached to the curb before the plastic dome is set into place. Experience has shown that it is desirable to protect the edge of the plastic dome by metal, thus providing some degree of fire resistance should a fire spread across the roof.

The attachment methods have been worked out to provide for constant drainage of condensate to the exterior of the building, while also making adequate provision for expansion and contraction of the plastic dome. The plastic materials have been rated as slow-burning and so have been approved by insurance laboratories. Other variations involving the use of plastic skylight domes have included ventilators or fans in a prefabricated curbing ready for installation on the roof. Accessories have included ceiling domes, usually of a diffusing material, which are mounted level with the interior finish of the building.

Considerable development work has been done to evaluate formed acrylic shapes for skylight use. Some evidence has been collected to indicate that a deeply formed dome approaching a hemisphere will actually gather more light into a given opening than would pass through the unglazed opening.

Another special shape developed for custom use is shown in Figure 2 where the acrylic plastic has been employed as a cylindrical top for a corridor and also has a very large multi-panel dome. Here the acrylic sheet has been engaged in metal channeling with provision for necessary thermal expansion and contraction, and is employed as the weather-proofing medium over roofs constructed of glass tubes.

Plastics for Glazing

Increasing quantities of plastics are being used for glazing, in many cases on a simple substitution basis for glass. Although the plastics are markedly higher priced than the glass replaced, they have proved to be economic in areas where high glass breakages occurred. The material used for this purpose is primarily acrylic sheet either in its natural transparent state, or tinted, translucent, or patterned to provide effective control of glare. Reinforced polyester sheet is becoming available as a flat material for this purpose and has been used in some installations.

When the plastic is used in relatively small panes it can be set in a sash in much the same manner as window glass, using some of the permanently soft glazing compounds. As the size of the pane increases, however, more careful consideration must be given to installation methods. Thus, for panes larger than two feet square, glazing beads or other similar channel methods of installation are recommended. While sizes as large as four feet square have been installed successfully in some types of commercial sash, these sash do not normally provide a satisfactory edge engagement. Special methods have been developed to adapt the standard sash where it is desirable to use it with plastic glazing.

Figure 3 shows the residential installation of acrylic glazing where the plastic sheets were formed on the site to the required curvature. This may be done safely so long as the radius of curvature exceeds 180 times the thickness of the sheet. In this particular case the use of the plastic sheet effected a marked saving as compared to the purchase of custom formed glass.

Flat acrylic sheets are being used increasingly for glazing in school buildings. Here they contribute not

Photo by Rohm & Haas Company

Fig. 3. Residential installation of acrylic glazing utilizes sheets formed on the site.

Photo by Rohm & Haas Company

Fig. 4. Formed acrylic windows used to glaze the entire upper perimeter of a school auditorium. The panels, each 62 by 90 inches, were formed to a flat bottomed, corrugated V-rib design.

Photo by Rohm & Haas Company

Fig. 5. Acrylic railing panels in Dallas theatre were carved and edge-lighted.

Photo by Rohm & Haas Company

Fig. 6. Luminous ceiling of control room in Richmond power station uses three-foot square panels of translucent white acrylic sheet to minimize glare.

Photo by Rohm & Haas Company

Fig. 7. Standardized coffer sections of acrylic form luminous ceiling combined with acoustical baffles in reception lobby.

Photo by Rohm & Haas Company

Fig. 8. Acrylic luminous ceilings, with incandescent spotlights for accent lighting, are used in Museum of Fine Arts, Boston.

only the shatter resistance needed to protect against breakage in playground enclosures, but also provide glare control through the use of tinted or diffusing materials.

Best use is made of plastic glazing materials when they are formed in shapes especially suited to the purpose. This is well illustrated in the preceding discussions of skylights where the doming of the thermoplastic materials produces a part ideally suited to the need. The same general architectural concepts are being extended to sidewall glazing where the forming of the plastic material is introducing a new three-dimensional look.

Figure 4 shows one application of specially formed glazing to the upper portion of a school gymnasium in Philadelphia. A specially formulated, blue tinted, translucent acrylic sheet was used for the forming of the V-rib panels. These panels are flat around their entire periphery, permitting easy installation of them in channel type mountings. In addition to adding an interesting texture to the building exterior, the forming rigidized the plastic sheet and permitted the use of a thinner, less expensive material. Other installations have used simply domed panels for the replacement of multi-pane steel sash in industrial locations where corrosion of the steel has been a serious problem. Obviously a great many other shapes and textures can be created readily wherever the architect or builder wishes to employ glazing to harmonize or contrast with the other building textures.

In addition, the forming of plastic glazing panels offers an unusual possibility of built-in sunlight control. For example, one side of the ribbed surfaces shown in Figure 4 could be opaqued by application of plastic coatings, thus admitting only northern or general sunlight to the building. Research into the full possibilities of these large one-piece Louverlite glazing panels is now under way, and data are being collected on light distribution in structure with plastic glazing in various designs.

Some work has been done with special shapes of reinforced polyester plastics. To date this work has been limited to coffer-like panels shaped primarily for rigidity, thus permitting glazing of a large opening with relatively thin sheet.

An intriguing development possibility lies in prismatic panes which might be extruded or molded from the thermoplastic acrylics. The molding process can easily produce a far more precise optical system than is practical in cast glass. Thus, acrylic panels could be designed and produced in thin sections to effect very good control of sunlight entering the building. Precisely molded prisms could be designed to direct sunlight to the upper portions of the room where it could be spread through the room to provide a satisfactory distribution of daylight. These panels could be quite thin and readily installed in standard metal or wood wash in contrast with the much heavier installation of glass block.

The use of two panels having their prismatic surfaces face to face would eliminate the problem of cleaning the prismatic surfaces, and at the same time provide insulating value. The practicality of such optical systems in thin sections was established some years ago with the development of production methods for magnifiers used on small television screens. For this purpose, lenses were

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molded into the acrylic sheet.

The use of the formed acrylics has made possible some new concepts in the solution of interior architectural problems. Shower curtains have been replaced with sliding panels made of rigidized tinted acrylic sheet. Similar panels have been used for partitions in schools and in the home. The plastic offers the advantages of light weight, safety from breakage, and a wide selection of colors and shapes.

Acrylic plastic sheets have also been used for unusual decorative effects in interiors. Figure 5 shows a railing in a Dallas theatre which has not only been decorated by carving the surfaces of the plastic, but has the decoration accented by edge-lighting. The unusual clarity of the acrylic plastic makes it possible to introduce the light into the material along any edge of the sheet. Decorations applied to the sheet surfaces by carving, painting, or scribing will glow attractively when so lighted.

Luminous Ceilings

The availability of large, light weight, shatter resistant plastic sheeting has made practical the even illumination of the entire ceiling in rooms. Such lighting literally brings the outdoors inside by producing shadow-free, glareless illumination at very high levels. The plastics used here have been either very thin vinyl sheeting in thicknesses of about 0.007-inch of acrylic sheet. The vinyl which is normally corrugated to sufficiently rigidize it for use in spans up to 36 inches, is available in rolls of any desired length.

The acrylic sheet has been used in thicknesses of about 0.020-inch when produced by a special process which toughens it by orienting the molecular structure. This material is limited at present to widths of about 24 inches. Larger sections of acrylic use standard production processes, and are made in thicknesses of about ⅛ inch and sizes up to five feet square. Large-size sections are rigidized either by corrugation or by forming into special custom shapes suited to the architectural decor. The acrylics are also available commercially in standardized coffer sections suited to mounting in either metal or wooden supports.

Systems have also been worked out whereby the plastic ceiling may act as the inlet for conditioned air. Sound absorbing baffles are often added to the ceiling and, in some cases, sound absorbing ceiling areas are used to surround illuminated areas. Costs of these plastic ceilings have ranged upward from $3.00 per square foot, including the electrical installations. In comparing this cost with other types of lighting, it should be noted that the plastic ceiling normally comprises the entire ceiling finish and thus provides substantial savings over conventional construction costs. In many cases of remodelling, luminous plastic ceilings have been used to conceal a maze of piping and ducts, thus achieving a clear interior with outstandingly good lighting at a low over-all cost.

Some use of plastics, particularly vinyls, has been made in eggcrate type ceilings. In general, these installations have not proved as satisfactory as the ceilings employing diffusing plastic panels, because the eggcrates permit reflection of the bare light tubes on articles located directly below the light sources. This reflection is particularly troublesome on drafting instruments or on the keys of business calculating machines.

Figure 6 shows an installation of flat acrylic sheet as the diffusing medium in a ceiling for a power house control room. In general, flat sheets are not used since it is necessary either to use rather thick sections to avoid an objectionable sag in the sheet, or else limit the spans to modules as small as two feet square. Rigidizing of the sheets by our corrugating permits spans up to four feet square, and also introduces textural possibilities. The corrugation also permits admission of ventilating air through the spaces at the ends of the corrugation, since the plastic sheets are usually supported by T-sections and there is some clearance between the web of the T and the ends of the sheets. The use of standardized

(*Continued on page 234*)

Photo by Rohm & Haas Company

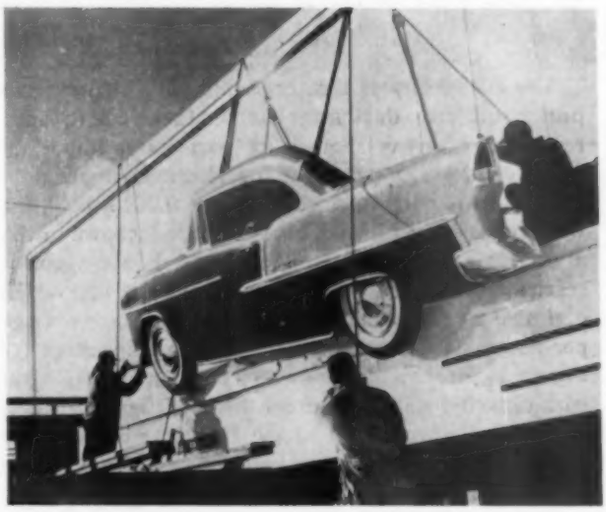
Fig. 9. Original installation of an acrylic luminous façade made at Food Fair store in Atlantic City, N. J. in 1948.

Display Uses Reinforced Plastic Replica of Chevrolet

A display which utilizes reinforced plastics in a giant replica of a 1955 Chevrolet has been installed in the Detroit, Mich., area. Marking the first use of three dimensions in a major automotive poster board campaign, the display creates the impression of a real car parked on the sign. The plastic replica, weighing 300 pounds and about 1½-times actual size, protrudes only about one foot from the surface of the 16- by 50-foot billboard.

The replica was achieved by Marshall M. Fredericks, nationally known sculptor, who began by shaping a clay mock-up to the required 24 by 8-foot dimensions. Two months were required by Fredericks and his three assistants to mold the necessary two tons of clay into the proper proportions. Upon completion of the mock-up, alternate layers of resin and glass cloth were applied to the clay to form a negative mask or pattern. After being removed from the clay and reinforced with a wood framework, the pattern was used to cast the finished replicas, also made of glass-reinforced plastic.

In addition to the display already completed, others featuring the replica are being readied for the Detroit area and other large cities.



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GEORGE MISTIC, *Director of Research*
Condenser Products Company, Division of
New Haven Clock & Watch Co., Chicago, Ill.

Plastics as Capacitor Dielectrics— 2. Polyethylene

The second of a five-part series on plastics being used as dielectrics or insulators in the electrical industry

The availability of thin gage film with high chemical purity, uniform thickness, low pin hole count, and a minimum of weak spots is of paramount importance when considering polyethyl for electrical applications. Such films ranging in thickness from 0.0015-0.002 inch were made available to Condenser Products more than a decade ago, and extensive investigation by our research engineers proved that this material had several desirable electrical and physical characteristics over paper and mica dielectrics. When used in capacitors (see Figure 1) either as the only dielectric or in conjunction with dimethyl silicone impregnant (see Figure 2), polyethylene was found to be ideal for radar circuit pulse-forming networks, high voltage D. C. and R. F. capacitors, and charge storage capacitors. These applications were made possible only after high temperature heat curing methods and aging cycles were developed to yield a stable capacitor unit out of an otherwise soft and elastic film.

At present, polyethylene has a maximum service temperature of 90° C. in capacitors. However, the recent development of X-ray irradiation has resulted in a highly heat-stable polyethylene whose usable range has been extended to 150° C. without impairment of desirable electrical characteristics. Currently manufactured irradiated polyethylene film will oxidize in air when exposed for long periods of time to temperatures of about 100° C. However, there are no deleterious effects when the film is operated out of contact with air. Condenser Products is presently directing its research staff towards utilizing this new type of irradiated film in capacitors for R. F. frequency applications where low dielectric loss is required at temperatures over 100° C.

General Characteristics

Polyethylene is insoluble in all solvents at room temperature. However, at temperature above 50-60° C. it is soluble in halogenated hydrocarbons and hydrocarbons in general. Although polyethylene swells slightly in oils at lower temperatures, it is not compatible with oils such as mineral oil above 60° C. Nevertheless, dimethyl silicone fluid over 50 centistokes in viscosity was found to be an excellent impregnant for polyethylene, thus extending use of the plastic to high voltage capacitor and radio frequency applications.

To prevent cracking of the polyethylene wire insulation due to weathering, certain additives such as antioxidants must be incorporated in the material. Adding antioxidants to polyethylene gives the plastic a volume resistivity at room temperatures that is somewhat higher than for unstabilized material. However, the volume resistivity is lower for the stabilized polyethylene at temperatures over 25° C. Also, the average dielectric

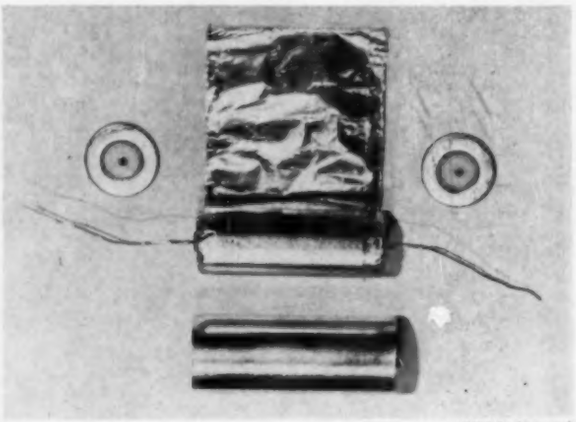

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Fig. 1. Capacitor components: (center) windings of plastic film and aluminum foil, with wire "pig tails" attached; (sides) end-seal caps which are threaded on wires and soldered to capacitor; and (bottom) capacitor casing.

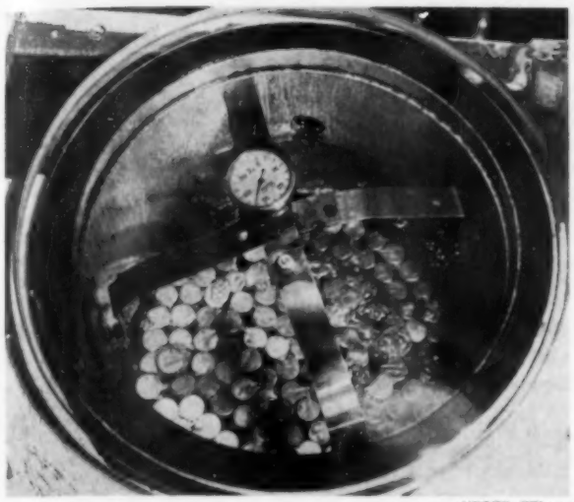

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Fig. 2. Tank for impregnating capacitors with silicone fluid. A vacuum is created and the fluid enters the capacitors through small end-holes that are sealed afterwards.

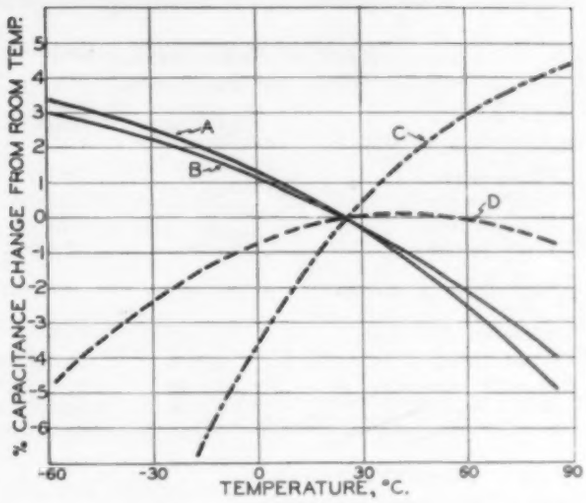

Fig. 3. Effect of temperature on capacitance at one kilocycle for various dielectrics: (A) silicone-impregnated polyethylene; (B) unimpregnated polyethylene; (C) silicone-impregnated cellulose acetate; and (D) mineral oil-impregnated paper.

strength decreases with an increase in percentage of antioxidant. To obtain the extremely high insulation resistance and low power factor properties needed for use in capacitors, it is desirable that the incorporation of additives be held to a minimum. This is especially true in the capacitor industry since a capacitor is impregnated or hermetically sealed.

Although polyethylene can be considered to be nonpolar, nevertheless it was found that it does have a dissipation factor and a very broad, small resonance at extremely high frequencies that are characteristic of polar materials. This quality is attributed to a small amount of oxygen that is built into the polymer during manufacture.

Also, it has been found that polyethylene, which is a highly branched instead of a straight-chain polymer, exists in both crystalline and amorphous forms in thermal equilibrium in commercially manufactured material. This fact probably explains the physical behavior of polyethylene and also its electrical behavior. Table 1 compares the properties of polyethylene with those of polystyrene.

In this table, polyethylene which is a pure hydrocarbon polymer is compared with polystyrene, another derivative of ethylene where one of the four hydrogen atoms is replaced by a phenyl group. The only other plastic material which compares with polyethylene is polytetrafluoroethylene (Teflon) where all four hydrogens of the simple ethylene molecule are replaced by fluorine.

Electrical Characteristics

Polyethylene has a measurable dissipation factor, and this characteristic and the dielectric constant are affected by temperature. Of the two types of capacitors manufactured (one being polyethylene alone, and the other polyethylene impregnated with silicone), the effects of temperature on capacitance and power factor are slightly different, as shown in Figure 3.

The dielectric constant of unimpregnated polyethylene decreases with increasing temperature from a

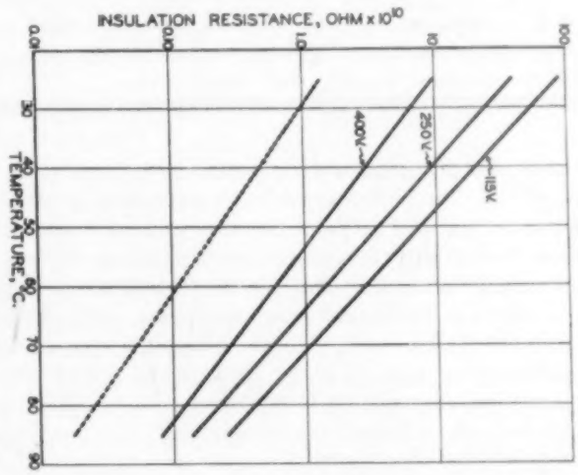

Fig. 4. Effect of temperature on insulation resistance at different voltages of a one-microfarad unimpregnated polyethylene capacitor made with 1.5-mil film. Dotted line is for mineral oil-impregnated paper and silicone-impregnated cellulose acetate capacitors at 250 volts. Values at 25° C. were determined by time-decay method, while values from 50-85° C. were taken with electrification method.

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Fig. 5. Rapid inspection test for dielectric strength checks capacitors at 150% of rated voltages.

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Table 1. Electrical Characteristics of Polyethylene and Polystyrene

	Polyethylene	Polystyrene
Dielectric Constant (25° C.):		
At 60 cycles	2.3	2.5-2.6
At 1000 cycles	2.3	2.5-2.6
At 1 megacycle	2.3	2.5-2.6
At 100 megacycles	2.29	2.5-2.6
Volume resistivity, ohm-cm	10^{18}-10^{19}	10^{19}-10^{22}
Power factor (25° C.):		
At 60 cycles	0.0005	0.0001-0.0003
At 1,000 cycles	0.0005	0.0001-0.0003
At 1 megacycle	0.0005	0.0001-0.0008
At 100 megacycles	0.0005	0.0001-0.0008
Dielectric strength (30-mil sample, parallel breakdown), volts/mil:		
At 60 cycles	1300	1700
At 1 kilocycle	900	1100
At 15 kilocycles	650	550
At 2 megacycles	335	300
At 4.2 megacycles	250	230
At 9.8 megacycles	175	150
At 18 megacycles	150	100
At 100 megacycles	125	50

value of 2.24 at room temperature to a value of 2.14 at 85° C. The power factor of polyethylene is approximately 0.0001 at 50° C., rises to a peak of 0.00025 at room temperature, and decreases to 0.000 at 75° C. It should be noted that the silicone impregnant changes the effects of temperature on capacitance very slightly.

Figure 3 also compares the effects of temperature on the capacitance of paper impregnated with mineral oil, and cellulose acetate impregnated with silicone fluid. However, the effect of temperature on the capacitance of paper condensers depends upon the impregnant; in this case, the mineral oil being non-polar the effects of temperature are not appreciable.

Effect of Frequency

The effect of frequency change on polyethylene capacitors is very slight. At 25° C., the capacitance will decrease 0.3% with a frequency change from 60 cycles to 10 megacycles. At higher frequencies the construction of the capacitor unit plays an important part. To prevent a shift in the effective capacitance of the capacitor for radio frequency work, all terminals and lead connections must be short and of low resistance, and the capacitor be wound in an extended foil type of construction. This type of construction will minimize the self-inductance of the capacitor and increase its Q-factor.

This construction will also reduce the effective series resistance of the condenser in order to take advantage of the extremely low power factor of the dielectric. As was previously mentioned, the power factor of unimpregnated polyethylene is quite small and does not change appreciably with frequency. However, in a capacitor construction where self-inductance and series resistance are present, the power factor of the capacitor will rise.

Table 2 shows the effect of capacitor size at several voltage ratings on the dissipation factor of the unit at frequencies to 50 megacycles.

In applications where a large radio frequency current is being passed through the capacitor, the dissipation factor causes internal heating of the capacitor. Thus, it is imperative that the dissipation factor be kept as small as possible. The internal heat rise of the capacitor in an ambient temperature of 65-70° C. should not be greater than 15-20° C. in order to not exceed the critical softening temperature of the polyethylene film itself.

The other limiting factor with respect to use of polyethylene type capacitors at radio frequencies is breakdown voltage. From Table 1, it will be noted that the breakdown voltages for unimpregnated film at various frequencies decreases considerably as the frequency increases. This volt-per-mil rating, however, can be increased considerably by use of special processing techniques and impregnation of the polyethylene units when used for radio frequency applications.

Capacitance Drift

When a polyethylene unit without silicone impregnation is properly processed and aged it has a very low capacitance drift at room temperature after cycling to 85° C. and back to room temperature, then to 60° C. and back to room temperature. This drift after heat cycling was found to be less than 0.25%, and the room temperature drift over a one-year period was less than 0.3%.

As Figure 3 indicates, it is possible to construct capacitors using polyethylene with a negative temperature coefficient of capacitance, and cellulose acetate with a positive coefficient of capacitance. In this manner, we can obtain a net percent change in capacitance very much smaller than either of these two films can give separately. It is possible to obtain plastic films with negative or positive temperature coefficients that will either cancel out each other in certain temperature ranges, or combine to provide a predetermined capacity shift due to temperature.

Insulation Resistance

The usual designation for the electrical resistivity of an insulating material is volume resistivity in ohm-centimeters. The volume resistivity of polyethylene film is usually designated by a figure without regard to temperature, charging time, and applied voltage. All of these factors affect the volume resistivity measurement of a dielectric.

The measurement is usually made by the brass electrode method, whereby the thickness, the area of the electrodes, and the resistance of the material are determined, and the volume resistivity calculated by the formula $P = R\ (A/D)$. Published figures for volume resistivity vary from 10^{13}-10^{19} ohm-centimeters.

The values for the polyethylene film used in capacitor dielectrics vary with applied voltage, time of electrification, and temperature. With 250 volts applied at 25° C. and an electrification time of two minutes, the volume resistivity is found to range from 5×10^{17} to as high as 5×10^{18} ohm-centimeters.

Table 2. Effects of Capacitor Size on Dissipation Factor vs. Frequency

Frequency	250 mmfd. 3,5000 volts DC	1,000 mmfd. 3,500 volts DC	2,000 mmfd. 10,000 volts DC	2,000 mmfd. 20,000 volts DC
10 kilocycles	0.00023	0.00023	0.00026	0.00030
100 kilocycles	0.00023	0.00025	0.00030	0.00035
1 megacycle	0.00032	0.00042	0.00049	0.0007
5 megacycles	0.0010	0.0013	0.0020	0.005
10 megacycles	0.0020	0.0032	0.0060	0.012
25 megacycles	0.0060	0.013	0.030	0.070
50 megacycles	0.013	0.040	0.080	0.150

Extending the above conditions to the measurement of the insulation resistance of a polyethylene film capacitor, two methods are in common use. One method uses a voltage of 100-500 volts D.C. to charge a condenser for two minutes, after which the leakage current is determined and the insulation resistance calculated. With longer periods of electrification the effects of polarization are reduced and the insulation resistance continues to improve.

The second method for measuring insulation resistance is known as the self-time constant method. Here, the condenser is charged to a certain voltage and then allowed to discharge through its own internal resistance. After a specific interval the final voltage is measured with an electrostatic volt meter, and the resistance calculated. This self-discharge method always results in a higher insulation resistance value than the two-minute charge time method. However, at higher temperatures the two methods conform more closely in results.

When the active area and film thickness are known, the insulation resistance of a capacitor unit can be calculated from volume resistivity. However, in those cases where the capacitance is quite small and, thus, the insulation resistance quite high, other circumstances must be considered, such as leakage between terminals and container, edge space leakage, and the effects of humidity on terminals and container. The effects of humidity and x-ray irradiation on the polyethylene film also are factors in determining the insulation resistance of a unit by the volume resistance formula. Insulation resistance versus temperature at several voltages for a one-microfarad polyethylene unit using film 1.5 mils thick is shown in Figure 4. This insulation resistance curve is linear on a semi-logarithmic scale.

As shown in Figure 4, the insulation resistances of mineral oil-impregnated paper and silicone oil-impregnated cellulose acetate are at least one decade lower than that of the polyethylene type capacitors. However, when polyethylene is impregnated with a non-polar liquid, such as silicone fluid, the high insulation resistance value is reduced to only 3% of the value of the unimpregnated polyethylene unit. This would bring the insulation resistance of a silicone impregnated polyethylene capacitor down to conform with that of a silicone impregnated acetate unit.

The reason for this large drop in insulation resistance is not immediately clear. Tests have shown that the phenomenon is related to the polarization effects between the silicone and polyethylene, and not to edge-space leakage. Tests have also shown that the drop in insulation resistance due to impregnation is not as large with a polar material such as cellulose acetate.

Dielectric Absorption

Since polyethylene plastic is essentially non-polar, its dielectric absorption is extremely small. When a capacitor is discharged, a certain amount of residual voltage remains at the terminals. This residual voltage depends upon temperature and charging voltage. For purposes of comparison the dielectric absorption is defined as the percent of maximum recovery voltage (relative to charging voltage) that remains after a condenser is charged for one hour and then discharged for one-third second.

For a polyethylene unit impregnated with silicone fluid, the dielectric absorption is 5% for all charging voltages and for temperatures to 75° C. For an unimpregnated polyethylene unit, the absorption is less than 0.5% at temperatures to 70° C. for all voltages.

Dielectric Strength

Published dielectric strength figures for plastic films are usually in volts per mil. However, this volts-per-mil figure varies according to the thickness of the sample tested, the time to breakdown, the rate of voltage rise to breakdown, and the temperature. Obviously, this figure cannot be used for the voltage rating of capacitors made with an extremely thin film, since a capacitor is required to withstand several thousand hours of continuous operation at high temperatures and continuously applied potentials.

The voltage rating for a film is arrived at by experiment. Typical tests for rating capacitors are given in Army-Navy specifications where the capacitor is required to withstand as high as 150% of its rated voltage for 250 hours at the operating temperature without failure. Voltage ratings obtained in this manner are 150-300% lower than published ratings from short-time or step-by-step test methods. A typical inspection text for dielectric strength is shown in Figure 5.

Published data states that the dielectric strength of a polyethylene sample 125 mils thick is 470 volts per mil at room temperature by short time tests. Prolonged testing of 1½-mil thick sections at 65° C. show that the film can be safely stressed at 1,000 volts per mil for well over 1,000 hours without failure. For the capacitor industry, therefore, a more usable value for evaluating dielectric strength would be the breakdown strength of a material in samples from ¼-10 mils thick.

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Corona Resistance

Among factors contributing to breakdown of the polyethylene insulation are dielectric heating at higher frequencies and, in several instances, the effect of corona. Corona is usually described as the partial breakdown of insulation due to concentration of electrical stress at sharp edges, or actual breakdown of the insulation when placed in series with another insulation having a different dielectric constant.

For use at D.C. potentials, polyethylene has very little corona. However, at frequencies from 60 cycles and up, the corona becomes apparent and is an important consideration in the service life and breakdown of the dielectric. For use at high voltages and frequencies, polyethylene usually is impregnated with an insulating oil such as silicone oil. However, corona discharge does occur in oil, and if the oil breaks down the corona will produce higher stresses on the polyethylene and erode away the surface of the dielectric, thereby reducing its thickness and causing a breakdown.

Most high polymer insulating materials, such as polyethylene, Mylar, polystyrene, nylon, and silicone, have about the same resistance to corona erosion. Kel-F and Teflon are particularly susceptible to the erosion effects of corona. At a frequency of 60 cycles per second, a 4.5-mil thick sample of polyethylene stressed at 600 volts per mil will average about 50 hours before breakdown occurs. The time to breakdown for polystyrene is approximately 75 hours, while that of Teflon is only about six hours.

The minimum voltage at which corona attacks the solid insulation is known as the threshold voltage or corona threshold voltage. For a sample of polyethylene one mil thick this minimum voltage is 500 volts R.M.S. (Roat Mean Square); for a 10-mil thick sample it rises to 1,200 volts R.M.S.; and for a 100-mil thick sample it is 5,000 volts R.M.S. This corona threshold voltage, however, depends upon the type of electrode system to diverge the electric field and sufficiently change the voltage points so that corona will start.

Applications

As previously stated, polyethylene is used as an insulation for cables at high frequencies because of its low loss at radio frequencies. Thus, the polyethylene used as a capacitor dielectric is also found to be useful in applications where audio and R. F. coupling is required in pulse forming and despiking networks, and in low and high pass filter networks. Other applications are those where extremely high insulation resistance is required in electrometer and oscillator circuits, electronic computers, and energy storage units.

Conclusion

It is evident that polyethylene, owing to its high insulation resistance and extremely low dissipation factor and dielectric absorption, has found its place in the electrical industry as an insulation and a capacitor dielectric. Many years of field experience with these capacitors has proven the reliability of this dielectric. Research is still continuing on polyethylene and, especially, on irradiated polyethylene for use at very high temperatures so that its fine electrical qualities may be extended to the upper temperature ranges.

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(Plastics for Glazing and Illumination, Continued from page 228)

coffer sections is illustrated in Figure 7, where they have been employed in a five-foot square.

The use of luminous ceilings sometimes produces such a uniform or bland lighting that accent lighting may become desirable. One method of achieving such accent lighting is shown in Figure 8 where incandescent spotlights have been built into the ceiling at the Museum of Fine Arts in Boston. The spotlights not only provide the accent, but mix their warmer light with the output of the fluorescent tubes normally used in luminous ceilings. In some cases luminous ceilings have in fact become true skylights in roofs. In these cases addition of artificial illumination between the plastic ceiling and the skylight carries the daylighting effect on into the night time.

Luminous Façades

The luminous ceiling concept has been carried outdoors in the application of luminous façades to store buildings. Figure 9 shows the historic installation of an acrylic illuminated store front made by Food Fair in Atlantic City in 1948. At the time of its installation this was probably the largest plastic item which had ever been made, but it has since been dwarfed by the expanses of more recent plastic façades. This installation has continued to give satisfactory service ever since, and has given considerable impetus to outdoor use of acrylic sheet.

The Food Fair installation employed custom formed sections to create the effects shown in the photograph. Many subsequent developments employ corrugated acrylic sheets which are now available from widely distributed suppliers. Illuminated plastic sheet can be combined with other materials and the lighting made an integral part of the design.

Reinforced polyester sheets have been used in store fronts to a limited extent but, in many cases, have not been as satisfactory as the acrylics because the presence of the glass reinforcement makes it impossible to achieve the same uniformity of color and light distribution.

—THE END

Cast Radar Maps from Polysulfide Polymer

Precise flexible relief maps and flexible molds to make the maps are being cast by Aero Service Corp., Philadelphia, Pa., for the United States Air Force from polysulfide liquid polymer, a product of Thiokol Chemical Corp., Trenton, N. J. These maps are used to train flight personnel in radar recognition of ground features at minimum cost.

The casting problem involved in making the maps is quite complex because of the close dimensional tolerances and the need for casting areas as large as 324 square feet. Selection of a suitable casting material involved a comprehensive development and testing program, since many resins tested were unsatisfactory because of residual stresses, difficult parting from the mold, or undesirable water absorption. Polysulfide liquid polymer was found suitable because it has good wave reflectance characteristics and negligible water absorption after cure; is an easy processing, cold setting compound that does not require pressure forming and has low or negligible shrinkage during cure; retains good dimensional stability without excessive distortion during storage; and relieves stresses in cured sections without cracking and with minimum distortion.

The first step in manufacturing is the drafting of a very accurate map on which contour lines and ground features are precisely indicated. Next, an exact relief model of the map is made up of layers of cardboard superimposed on one another, with a scale of 1/200,000. When completed, the model is coated and a layer of plaster applied.

Fig. 1. Spraying plaster model with separating layer of wax before casting.

Fig. 2. Pouring liquid polymer into 6 x 9-foot mold model.

Fig. 3. Leveling off casting mixture against model.

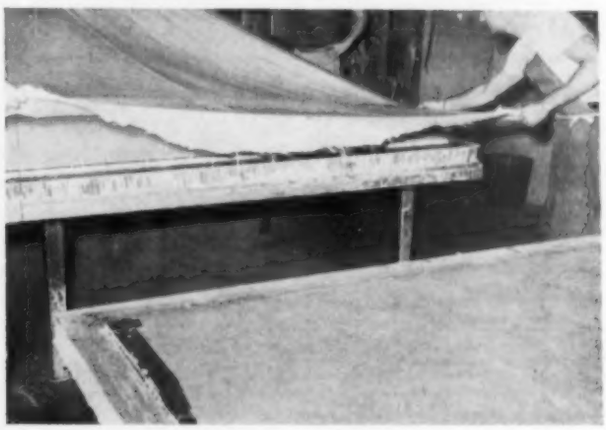

Fig. 4. Stretching fibrous glass backing on plaster model.

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After the master model has been checked and measured, the process of casting of flexible mold is begun. The plaster-faced model is accurately leveled and positioned, and coated with a separating layer of wax. A negative female mold is cast which, after setting, is separated from the model. The final relief map is cast against the flexible negative mold with wax as a parting agent. Metal inserts to simulate buildings and other man-made features are then inserted in the map.

The polymer compound is prepared by incorporating suitable fillers and a catalyst into the liquid polymer on a three-roll paint mill. Several hundred pounds of casting compound are used for the large maps. The shrinkage on large maps during casting is extremely small and predictable, usually in the order of 0.5%. Completed maps are stored by rolling onto helical cylinders.

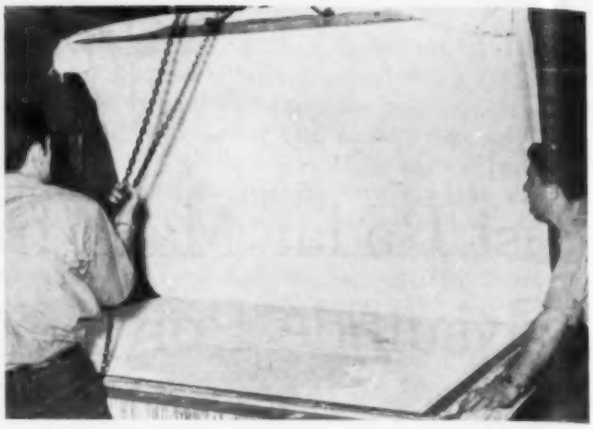


Fig. 5. Stripping casting from model.

(Recent Advances in Epoxy Resins, Cont'd. from page 217)

phenolics, melamines, and ureas, to amines, polyamides, and esters. End-uses include drum linings; chemically-resistant coatings for storage tanks, furniture, and processing equipment; appliance and metal surface finishes; paper coatings; collapsible tube and can linings; concrete paints; and spar varnishes.

Impregnating

Epoxies are used for impregnating porous metal castings, as well as special alloy steels used as transformer cores.

Laminating

In general, epoxies are used in both dry and wet lay-up methods for the manufacture of reinforced laminates. Low-viscosity liquid resins, plus hardeners, are used with glass to produce exceptionally high strength laminates by wet lay-up methods (see Table 5). (The lay-up technique is shown in Figure 4.)

The dry lay-up method, utilizing pre-impregnated glass cloth, generally employs solutions of low molecular weight, solid epoxy resins and heat-setting hardeners (e.g., dicyandiamide).

Tooling

Low-viscosity epoxies, incorporating both metallic and mineral fillers, are used with various hardeners to produce a wide variety of dimensionally stable tools.

Table 5. Comparison of Araldite 502 Laminates Using 181 Cloth With Different Finishes

	112 Finish	Volan A Finish	Garan Finish
Flexural strength, psi.:			
Dry	41,000	65,000	47,000
2-Hr. Boil	34,000	53,000	38,000
Modulus of elasticity in flexure, psi. x 10^6			
Dry	2.01	2.23	1.88
2-Hr. Boil	1.75	2.02	1.88
Resin content, % by wt.	40	42	40
Thickness of laminate, in.	0.085	0.085	0.085

These tools are now being employed in various metal forming, fabricating, and assembling operations. They are also used as vacuum forming molds, and low-pressure molding dies.

Conclusion

Epoxies, due to their outstanding and perhaps anomalous properties, are finding uses in a wide variety of applications. Although, they have already established a place for themselves in the field of thermosetting resins they will play an even more important role as new and improved curing systems are developed.

—THE END

(Production Preparation for New Compression Molds, Cont'd. from page 221)

right diameter to slip easily into the cored holes. Of greater importance, however, is the necessity of their having the required heat capacity, since the use of arbitrary wattages will not give satisfactory molding conditions. Thermostatic controls are placed on both the top and bottom parts of the die to permit the use of any desired temperature differential between the two halves.

Mold Heat Calculations

In order to arrive at the correct amount of heat required for a new mold the following formula should be used:

$$K = \frac{W \cdot S \cdot T}{3412 \cdot H}$$

where K = Number of kilowatts required
S = Specific heat
T = Temperature rise, °F.
H = Heat-up time, in hours
W = Weight of the mold, in pounds

From the above it can be seen that further calculations will have to be made in view of the fact that the weight of the die has to be figured.

As an example, let it be assumed that the heater plate shown in Figure 7 is to be used as a mold with approximately the same thickness of steel. Let it be further assumed that the dimensions of the die are 24 x 18 x 2-inches. From these figures the weight of steel can be obtained as follows:

Wt. = 24 x 18 x 2 x 7.85 x 0.0361 = 245 pounds

Now using the heat formula:

$$K = \frac{245 \times 0.12 \times 300}{3412 \times 1} = 2.50 \text{ kilowatts}$$

Adding a 14% allowance for heat loss, we obtain a final heat requirement of 2.85 kilowatts.

These figures are based on using 300° F., as the required temperature rise, which would bring the mold temperature up as high as 370° F. The specific heat of steel is 0.12, and heat-up time should be no longer than one hour. On the basis of these calculations it would be practical to use two of the 1,000-watt cartridges on the outside, and one 850-watt unit inserted through the center of the plate.

Mold Insulation

Regardless of the type of heating used for the molding process, there is a tremendous thermal loss through radiation and conduction. Dies are made of steel, and the presses are solidly constructed of either cast iron or steel. Provision must be made, therefore, for adequate insulation. Figure 5 shows a typical mounting of the lower half of a compression mold. Loss of heat by convection is reduced by the air gap between the press platen and the die itself. The insulation placed between the mold and the parallel bars minimizes conduction losses.

Asbestos boards about ½-inch thick are generally used for insulating purposes, and these boards require a certain amount of preliminary designing. This work, also, may be done prior to arrival of the new mold. The over-all size and thickness of the boards must conform to the specifications of the die. During the time that the mold is being built, the length of the ejector pins must be measured accurately. As can be seen, there is a definite relationship between the pin length and the depth of the die plus the height of the parallel bars. If, for instance, the insulating board shown in Figure 5 is ¼-inch thick, then the knockout pins must be made longer by a corresponding amount.

There is more to be done than merely cutting the asbestos to the exact shape of the mold. Knockout pins must pass through the insulation, so holes similar to those shown in Figure 8 must be drilled for that purpose. Correct alignment of these holes is accomplished by a transfer process. The exact locations of the pin holes in the back of the die are accurately dimensioned, after which these measurements are transferred to the insulation board. The holes must always be drilled slightly oversize to permit free movement of the pins during the molding operation.

Conclusion

Delivery promises on new compression molds are usually far too long to suit the average molder or his customer. However, construction of these dies entails the use of much time and skill. A sufficient number of weeks must be allowed to permit molds to be made in strict accordance with specifications.

Much of this waiting time may be used to distinct advantage. The plastics engineer is faced with many preliminary problems which can be solved during the time that the molds are being built. Arrangements should be made to have the molding compounds received and properly allocated; the loading board made; the heating units selected; and, finally, the insulation boards made ready. If all these preliminary precautions are taken, full-scale production can commence on the same day that the mold is delivered.

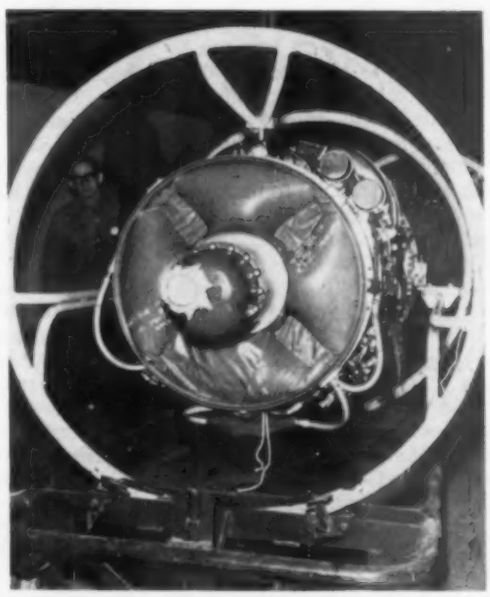
—The End

Vinyl Cover for Jet Engines

An inflatable cover of electronically-sealed vinyl sheeting has been developed by Republic Aviation Corp., Farmingdale, N. Y., to provide an immediate tight seal for jet engines throughout the assembly line. The new "plastic doughnut" is inflated into place within the nose of the engine, protecting it from the infiltration of dirt and foreign objects.

Small openings in the main fuselage duct allow easy access to a folded valve which deflates the cover for removal prior to engine run-up. Having no metal or hard parts, the material can pass through the engine without damaging the rotor blades or other parts, should it be inadvertently sucked in by the jet intake.

The covers can be re-used, according to Republic, and present little storage problem. Lustra-Cite Industries, Inc., New York, N. Y., has been licensed to manufacture them for sale to the industry.



Republic's Inflatable Vinyl Cover in Place on Aircraft Engine Nose

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News of the Societies

Grayson Addresses Appliance Engineers on Plastic Tooling

Plastic tooling progress depends less on the so-called "ideal" resin than on proper adaptation of the materials, according to Robert A. Grayson, Marblette Corp., Long Island City, N. Y., in a speech before the Appliance Engineers Society in Louisville, Ky., on March 9. Mr. Grayson was a featured speaker at the society's plastic tooling forum, held at Appliance Park under General Electric Co. auspices.

While plastic tooling cannot hope to solve all production problems, Mr. Grayson felt that these materials had six fundamental assets: low cost, ease of production, less lead time required, facilitation of design changes, light weight, and corrosion resistance. In addition, intricate shapes and complex contours do not materially affect the die cost once the model has been completed.

Other speakers included Robert H. Voss, Warren Plastics & Engineering, Inc., Detroit, Mich., and Frank L. Bogart, Marblette Corp.

Kemper Talks on Steel Hobbing

The fifty-three members and guests of the SPE Upper Midwest Section were addressed by W. H. Kemper, Carpenter Steel Co., Reading, Pa., at their March 21 meeting in Minneapolis, Minn. It was brought out that clean steel depends entirely upon rigid control and inspection during each step of processing and eventual shipment to the consumer.

Hobbing steels call for grinding and polishing operations on blank and hob respectively, according to Mr. Kemper, using a good lubricant such as copper sulfate or blue vitriol coated with a few drops of mercury. In some instances, faster hobbing can be accomplished by starting at a low pressure with a rapid build-up to the higher pressures normally required. Good hobbings are said to be equally dependent on the grades of steel used and processing know-how.

Northeastern Section Tours Natick QM Laboratories

The Elastomer and Plastics Group, Northeastern Section, ACS, toured the new laboratories of the Quartermaster Corps, U. S. Army, at Natick, Mass., April 12, and were briefed on current research and development activities there by scientists of the Corps' chemical and plastics division. Some 230 members and guests of the group were present.

J. Fred Oesterling, chief of the chemicals and plastics division, described the work being done by his own section, as well as that of the other divisions at Natick, including dispensing and handling equipment, fire and protection, mechanical, pioneer, and textile, clothing, and footwear.

The laboratories of these divisions were inspected on the tour, essential equipment explained by researchers, and work-in-progress outlined. In the plastics laboratory, a new development in air-delivery molded pallets, nestable and built around Cellotex or balsa wood, was exhibited, as well as fiber-glass boat-sleds with laminated phenolic runners.

After the tour, the group assembled in the Corps' auditorium to hear talks by Juan C. Montermoso, chief of the rubber section, and J. Alden Murray, chief of the plastics section, on research activities in their own departments.

Dr. Murray pointed out that his section was not concerned with the development of new plastics so much as trying to find new applications. Plastics, he said, were important to the military because they were non-critical materials and could be produced quickly and in great quantities. Now under study were such practical commodities as dishware, buttons, sleds, snowshoes, skiis, foot lockers, parachute boxes, typewriter cases, field desks, pallets, packboards, air delivery platforms for jeeps and trucks, and hard-wearing chevrons.

Parry Speaks on Epoxy Resins

Harvey L. Parry, Shell Chemical Corp., spoke on "Recent Developments in the Use of Epoxy Resins" before a combined meeting of the SPE Northern Indiana Section, the ACS Northeastern Indiana Section, and the Fort Wayne Rubber & Plastics Group. The meeting was held March 15 at Indiana Technical College, following dinner at Monochios Restaurant in Fort Wayne.

Mr. Parry limited his talk to structural applications, illustrating by graphs and slides the various properties of epoxy resins. Variable properties such as low shrinkage, adhesion, shear strength, cohesion, wetability, chemical resistance, and electrical properties were discussed in detail. The resins themselves are infusable and insoluble following cure, and show excellent adhesion to metals.

Although ultra-violet light darkens epoxy material, it causes no material harm. Epoxies have been used to coat the insides of pipe lines which have already been laid, according to Mr. Parry, utilizing the high strength qualities obtainable with pressureless room-temperature cures.

Buffalo Section Addressed on Electro Forming of Molds

"Electro Forming of Molds" was the subject of an address given by W. J. R. Stokes, III, Electro Mold Corp., before the SPE Buffalo Section at the Park Lane Restaurant, Buffalo, N. Y., on March 14. Defining electro forming as the process of plating over a master by means of electrolytic deposition at the cathode terminal, often resulting in a form thick enough to have a structure all its own, Mr. Stokes pointed out that such masters can be made from a variety of materials, including methacrylates, acetates, cast phenolics, styrenes, and brass or other metals.

The forms are first sprayed with a film of parting agent, a few molecules thick, to prevent the plate from sticking, and then plated until the desired thickness is obtained. Nickel is a preferred material for thermoplastics, while chrome is better for phenolics, which tend to wet nickel.

The use of a copper plate over nickel is an interesting application of the plating technique, according to Mr. Stokes. Nickel is first plated over the master to a depth of $\frac{5}{32}$-inch, and the copper then plated over the nickel. The excellent thermal conductivity of the resulting mold improves cycling on injection molding machines. Such a mold does not have the hardness of a hobbed cavity but the hardness extends deeper.

A hard-to-make cavity is easily achieved through electro forming, Mr. Stokes said. Even deep cavities provide no difficulty, with area, not detail, determining the cost, and neither polishing nor heat treatment required. Finest detail is obtained with brass masters, although a Kirksite backing is often needed for reinforcement purposes. In manufacturing economy, Mr. Stokes concluded, electro forming is second to no other method.

Deitz Discusses Stress Curves

The Reinforced Plastics Group of the New York Section, SPE, held a regular dinner meeting on March 30, 1955, at McGinnis' Restaurant, Jamaica, New York.

The highlight of the meeting was a talk by Dr. Albert G. H. Dietz, Professor of Building Engineering Construction, Massachusetts Institute of Technology, on the subject of "Stress Consideration in Reinforced Plastics." Illustrating his talk with graphs and diagrams, Dr. Dietz discussed the possibilities of engineering a reinforced plastics piece so as to tailor the strength properties to fit the stresses.

According to Dr. Dietz, since reinforced plastics are likely to be nonisotropic, the combined action of fiber and resin enters into the over-all behavior of the material. This combined action of fiber and resin can be computed if the stress-to-strain behavior of each is known. The speaker then proceeded to show how the stress-to-strain relationship can be determined.

Dr. Dietz set up the stress-strain curves for a fibrous glass-reinforced plastic rod, and discussed the various equations that can be used to determine stress curves in those applications where woven fabrics are

used as the reinforcing material and where layers of reinforcing materials oriented in two directions are laminated together. To illustrate the latter point, Dr. Dietz took a theoretical application—a reinforced plastics pressure tank—and worked out for the audience the step-by-step procedure necessary to determine the stress curves.

A lively question-and-answer period followed Dr. Dietz's talk and the meeting closed with the presentation of a movie entitled, "Fabrication Studies of a Glass-Reinforced Plastic Wing." The movie, presented by Cornell Aeronautical Laboratory by George T. Overholt, Jr., American Cyanamid Co., showed the various operations in the production of a reinforced plastic guided missile wing with an isocyanate foam core.

Decorating Techniques Discussed

The New York Section held its regular monthly dinner meeting on April 20th at the Gotham Hotel. Due to the illness of President G. Palmer Humphrey, R. C. Molding, Inc., the meeting was conducted by Arthur S. Jacobs, Augusta Plastics, Inc., who also served as program moderator. Approximately 95 members and guests were in attendance to hear a symposium on the latest advances on decorating techniques in the plastics industry. The speakers were Robert B. Way, president of Finish Engineering Co., Inc., who discussed "Spray Painting and Automatic Wiping Machines"; William F. Grupe, Peerless Roll Leaf Co., Inc., on the subject of "Roll Leaf Stamping for Decoration and Trademark Identification of Plastics" and concluding was Carl Johnson, director of research, Markem Machine Co., on "Evaluation of Dry Offset as a Method of Decorating Molded Plastics."

The symposium basically dealt with the types and evaluation of machinery and equipment in the decorating field. Mr. Way illustrated his discussion with a movie depicting spray painting, wiping, and mask washing machinery in actual use. Mr. Grupe spoke on hot foil decorating from the very beginning up to the present day. Mr. Johnson illustrated his talk on dry offset and impact printing with slides of various offset techniques and samples using this form of decoration. All three speakers concurred in the desire that product designers using plastics as a material first consider the problems of decorating, as against the standard practice of constructing a part and then facing the task of satisfactory decoration.

Due to the length of the program, reports were eliminated. Table favors and door prizes were donated by Koppers Co.

Toledo Section Reports

SPE's Toledo Section held its first meeting of 1955 on January 26 at the Toledo Yacht Club. Robert L. Butzko, Auto-Vac Co., addressed the 35 members and guests on the topic of "Vacuum Forming," pointing out that sheet forming is strictly an American process developed for reasons of economy.

Among the products being produced by this method are Christmas decorations, refrigerator door liners, toys, and luggage. Here, the reasonably priced vacuum forming machines are used to replace the expensive 200-300 ounce injection machines formerly required. A ½-inch vacuum is used, and a surge tank is considered essential equipment.

Mr. Butzko demonstrated a number of samples of vacuum formed ware. Fourteen different plastic materials of varying thicknesses can be formed, with no limit established on object size. Molds can be made from various materials such as epoxy resins, hydrocal plus resins, phenolics, aluminum, and other metals. The biggest single problem is mold shrinkage.

The February meeting was suspended to allow participation in Engineers' Week. The next meeting took place on March 30, at which time the following new Section officers were installed: president, D. W. Bowlin; vice president, Elmer Faber; secretary, Kenneth McGill; and treasurer, Frank B. Rosenberger.

Speaker for the evening was W. J. B. Stokes II, Electromold Corp., who addressed the group on "The Electroforming Process for Making Molds." The talk was similar to Mr. Stokes' SPE national conference paper, last January.

Awards Plastics Scholarship

The SPE Eastern New England Section awarded the first scholarship in plastics engineering to Lowell Technological Institute to cover a year's tuition for a deserving student. In answer to an ever-increasing demand by industry for engineers trained in plastics, the Institute has initiated a full four-year course, at the completion of which a student will receive a bachelor of engineering degree in plastics.

As part of the education activities, the Eastern New England Section is presently engaged in acquainting the various educational institutions of this need for trained plastics specialists. The program is actually a two-fold one: first, interesting the schools in adopting a plastics curriculum; and second, making high school students aware of the future awaiting them should they decide on plastics engineering.

Newark Section Hears Wismer

Marco Wismer, Ciba Co., addressed the April 13 meeting of SPE's Newark Section on "The Chemistry and Applications of Epoxy Resins." Eighty-eight members and guests attended the dinner-meeting, which was held at Military Park Hotel, Newark.

Epoxy resins or, more accurately, ethoxiline resins are polymerized from bisphenol-A and epichlorohydrin with either acid or amine hardeners. The acid hardeners such as phthalic anhydride give greater cross-linkage and a lower yield with increasing temperature. Amines give an addition reaction of one amine to five epoxy groups.

Epoxy resins have shown good alkali and water resistance, good adhesion, low shrinkage, high impact strength, and low heat loss. These characteristics make them especially valuable in the coatings field. Recent applications have been in the tooling adhesive, and reinforced plastics.

It was pointed out that the resins are too viscous for paper laminating. Tricresyl phosphate, HB-40, and dibutyl phthalate were recommended by Dr. Wismer as excellent plasticizers. Glycidyl ethers were suggested as diluents, and polyamides and polysulfides as flexibilizing agents.

Northern Indiana Panel

On April 25 the SPE Northern Indiana Section held a panel discussion on "Low Pressure Laminates" at Manchios Restaurant, Fort Wayne. Phil Magner, General Tire Co., opened the forum with a discussion of the resins used, their processing, and applications. The various types of glass reinforcements, thicknesses of materials used, and preforms were explained by Dan Ashby, Owens-Corning Fiberglas Corp. Jerry Jehl, Pribble Plastics, spoke on laminating processes, illustrating his talk with mold sketches and sample applications. The panel concluded with a detailed description of molding compounds by Howard Turner, U. S. Rubber Co.

Polyester and Epoxy Catalysis

Over 120 members and guests attended the April 7 meeting of SPE's Southern California Section at Scully's Restaurant, Los Angeles, Calif. The meeting featured a panel discussion by Robert Steinman, Garan Chemical Co.; Joseph Philipson, consultant; and Ben Carroll, Furane Plastics, Inc. of the various catalysts and accelerators used in the processing of epoxy and polyester resins.

The manufacture of polyesters was covered with emphasis on vinyl crosslinking agents, and the characteristics imparted by the various acids and glycols used during esterification. In the field of epoxies, acid and amine-type cures were stressed, also additives for lengthening pot life.

Phenolic Compression Molding

Robert L. Davidson, Kurz-Kasch, Inc., spoke on "Phenolics in Compression Molding," at the April 18 meeting of SPE's Southern Section. Thirty-five members and guests attended the meeting, which was held in Mammy's Shanty, Atlanta, Ga.

Filled, unfilled, and glass-reinforced phenolic parts molded by the compression technique were described by Mr. Davidson. The chief limitation to phenolics is their narrow range of color; however, this factor is being offset by the ever increasing number of applications for phenolics in fields where plastics previously had not been used. As an interesting sidelight to the quest for additional uses of plastics, Mr. Davidson presented statistics showing that the majority of plastics fabricators do not employ a single graduate engineer.

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Philadelphia Section Panels

The March 22 and April 26 meetings of SPE's Philadelphia Section took the form of panel discussions on "Reinforced Plastics" and "Methods of Making Mold Cavities," respectively. The latter was a joint SPE-SPI dinner meeting, and both meetings were held at Franklin Institute.

W. K. Fisher, Naugatuck Chemical Division, U. S. Rubber Co., opened the reinforced panel with a discussion of the six commonly used types of polyester resins. Using the drop-ball test, he demonstrated the impact strength of glass reinforced laminates as compared to the resin alone and other materials. Mr. Fisher also demonstrated a vacuum-bag molded fender and a matched-metal-die molded wash tub, emphasizing the importance of using a parting agent and shell coat, and the proper choice of resin.

The various types of glass fibers used in reinforcing plastics were discussed by R. G. Knowles, Bigelow Fiber Glass Products div. of Bigelow-Sanford Carpet Co. He explained how the fibers are processed into mats, molding compounds, and rovings. Glass fibers must be lubricated, and starch sizes, which are required for weaving cloth, must be burned off before coming into contact with the resin.

Molding methods were reviewed by H. L. Darby, Winner Mfg. Co. Here, the number of pieces to be produced usually determines the method used. Contact or hand lay-ups are employed to produce a limited number of pieces, since mold amortization requires a relatively long production run. Weight-strength ratio is another factor which may cause the molder to choose high pressure molding. Compromise methods, such as vacuum or pressure bag molding, can frequently be used to satisfy the most stringent demands of short production runs.

The April panel consisted of J. W. Stokes, Electromold Corp., who spoke on "The Electroforming Process for Making Mold Cavities," and Joseph P. Healy, Manco Products, whose topic was "Beryllium Copper Molds." Mr. Stokes' address was similar to the paper he presented at the SPE annual conference.

Mr. Healy indicated the advantages of the proper use of beryllium copper molds, stressing the particular applications where this method can be used to advantage. Cost and mold strength required are the main factors determining its choice. He illustrated his talk with particularly successful applications of the technique.

Chicago SPE-SPI Meetings

The SPE Chicago Section and SPI Midwest Chapter met jointly on February 16 to hear an address by Clifford E. Evanson, T. A. B. Engineers, Inc., on "Cutting Costs with Automation." Over 105 members and guests attended the meeting, which was held at the Western Society of Engineers dining room, Chicago, Ill.

Automation can and will be used in the plastics industry, according to Mr. Evanson, even though production may involve making several parts in the same press or extruder, and in a short period of time. He cited instances where production rates have been increased, quality levels raised, labor forces upgraded, and a company's position bettered through partial or complete automation. Contrary to the opinion that automation replaces workers, Mr. Evanson described a plant which doubled its number of employes upon adoption of automation, through lowered costs and increased product demand.

The best approach to automation is through competent professional appraisal, to determine whether a given plant can use automation on an economically sound basis and what is the most practical way to proceed. Mr. Evanson also showed and narrated a film by the Ford Motor Co., entitled "Technology for Tomorrow." The movie depicted the degree of automation at Ford's foundry and engine plants in Cleveland, O.

The annual Ladies Night meeting of the two groups was held March 16, attendance numbering 95. Gertrude Bailey, Monsanto Chemical Co., addressed the group on the topic of "At Home with Plastics," illustrating her presentation with a new color film recently produced by SPI. Miss Bailey pointed out the various applications of plastics in the home, and described their care and cleaning.

What is statistical quality control? What can it do for you? Where can you apply it? These questions and many others were answered at the April 18 meeting of the two organizations. Over 140 members and guests attended the forum discussion, which was held at the Western Society of Engineers dining room.

M. E. Hill, Gosset & Hill, served as moderator for the panel, which included Eugene G. Freund, Victor Adding Machine Co.; Harry M. Neben, American Phenolic Corp.; and William L. Lieberman, Gudeman Co. "Incoming Quality Assurance" was the topic of Mr. Freund's address, in which he presented the industry's problems in meeting quality standards.

Mr. Neben, in presenting "Process Controls," touched on the question of how to inspect. Mr. Lieberman rounded out the panel with a discussion of "Process Capability," wherein he covered the problems confronting the quality control engineer.

Miami Valley Section Tours

Plastics Research Products Division, Grimes Mfg. Co., Urbana, O., was host to the Miami Valley Section, SPE, on April 7. Following dinner in the company cafeteria, the 49 members and guests were shown a film entitled "Plastics Is Our Business," which stressed the engineering of plastic materials to specific applications.

Following the movie, the group was taken on a conducted tour of the molding plant's facilities. Equipment for molding all types of thermosetting resins were demonstrated. Among the custom items being processed during the tour were radio cabinets, washing machine agitators, TV antenna rotor housings, and various household appliances. Plastics Research Products also molds terminal blocks and housings for the parent Grimes Company, manufacturers of aircraft electrical components.

Cleveland-Akron Section Meets

A. R. Morse, Injection Molders Supply Co., addressed the April 18 meeting of SPE's Cleveland-Akron Section on "Standardization of Injection Machine Heating Cylinders." Approximately 100 members and guests attended the meeting which was held at the Spanish Tavern, Brecksville, O.

According to Mr. Morse, the biggest single problem encountered by injection molders involves working new materials with inadequate and obsolete equipment. These new compounds usually show a decrease in safe working temperatures. IMS, in cooperation with Wheelco Instruments Division, Barber-Colman Co., conducted a series of tests to evaluate the heat transmission characteristics of injection molding cylinders.

Uniformity and proper thermocouple location were then analyzed, and it was found that the top of a horizontal heating cylinder is some 10°-15° F. hotter than the bottom. One suggested improvement was the addition of several thermocouple control points to equalize and control heating. Mr. Morse's complete paper will appear in the June issue of PLASTICS TECHNOLOGY.

SPE Quebec Hears Richardson

"The plastics industry is wasteful, in that it salvages only 10% of its repairable tools," according to L. D. Richardson, Eutectic Welding Alloys Corp., in an address before SPE's Quebec Section on April 28. Fifty members and guests attended the meeting, which was held at the Queen's Hotel, Montreal.

Five basic steps necessary for successful welding of damaged tools and molds were presented by Mr. Richardson: analysis of the base metal; calculation of the effect of heat on the metal part; weldment design; determination of metal affinity; and a consideration of the metal's hardness. Techniques employed by Eutectic include "buttering" the surface to be welded, compression welding, peening, and the cushioning of hardened tool steel parts with a soft metal such as an 0.003-0.005 inch copper shim.

Ontario Section Meets

The SPE Ontario Section held its regular dinner-meeting on April 26 at the St. Regis Hotel, Toronto, Ont., with 40 members attending. Sid Bersudsky, Sid Bersudsky & Associates, spoke on "Angles on Sales Curves" as pertaining to industrial design.

Modern design can be translated in terms of sales, according to Mr. Bersudsky, and the mere copying of U. S. items is not the answer to Canadian taste problems.

NEWS of the INDUSTRY

Koppers Buys American Aniline

Koppers Co., Inc., Pittsburgh, Pa., has agreed to purchase all the outstanding capital stock of American Aniline Products, Inc., for an undisclosed figure. The company has a plant in Lock Haven, Pa., a warehouse in New York City, and laboratory-warehouse facilities in Providence, R. I., Charlotte, N. C., Chattanooga, Tenn., Columbus, Ga., and Chicago, Ill. Sales offices are maintained in Philadelphia, Los Angeles, and Chicago. American Aniline also has a wholly-owned Canadian subsidiary, Dominion Anilines and Chemicals, Ltd., with offices in Toronto and Montreal.

Koppers plans no change in the corporate name, and will operate American Aniline as a wholly-owned subsidiary. As such, it will come under the general supervision of the chemical division. American Aniline manufactures dyestuffs, chemicals, and intermediates for the textile, plastics, leather, petroleum, and paper industries. It is expected that the acquision will enhance Koppers' position in these fields.

Pigment Dispersions Plant Opens

A new plant to supply polyethylene producers with pigment and carbon black dispersions was formally opened on March 10 at Orange, Tex., by Acheson Dispersed Pigments (Texas) Co. The new plant is a subsidiary of Acheson Industries, Inc., New York, N. Y., and is an extension of an operation already well founded under the name of Acheson Dispersed Pigments Co., Philadelphia, Pa. This latter company will generally supervise production at the new plant, and market its products. Acheson is already well known in the plastics fields for its line of color and carbon black dispersions in the form of masterbatches, pastes, and dispersions in plasticizers or other vehicles. With polyethylene, dispersed carbon black has little or no effect on the mechanical properties of the plastic, but minimizes photo-oxidation of the surfaces of products exposed to outdoor weathering and ultra-violet radiation.

Forms Plastics Corporation

A new corporation, Plumb Chemical Corp., has been formed for the manufacture of fibrous glass-reinforced molding compounds. An affiliate of Fayette R. Plumb, Inc., the firm will have plant and offices at 4837 James St., Philadelphia, Pa.

James L. Harvey, newly appointed president of the organization, announced that the compounds would be available as precatalyzed resins under the trademark Fibercore. Three grades will be marketed: chemical, electrical, and flame resistant.

BPI Summer Courses

The Polytechnic Institute of Brooklyn, Brooklyn, N. Y., will conduct the twelfth in its annual series of summer laboratory courses and associated lectures, beginning June 6. The program was created to meet the demands of working scientists and technicians for advanced and intensive instruction on the use of specialized physical tools in chemistry and physics.

The three courses scheduled include "Progress in Polymerization and Copolymerization Techniques," June 6-10; "Properties of Macromolecules in Solution, Including Polyelectrolytes and Other Water Soluble Polymers," June 13-17; and "Industrial Applications of X-Ray Diffraction," June 6-17.

Inquiries should be adressed to Mrs. Doris Cattell, Secretary, Summer Laboratory Courses, Polytechnic Institute of Brooklyn, 99 Livingston St., Brooklyn 1, N. Y. Assistance in obtaining accommodations in the vicinity will be given all registrants upon request.

Ferro to Market Milled Glass

Milled glass fibers have been added to the line of reinforcing materials for molded and laminated plastics by Ferro Corp., Nashville, Tenn. Made from continuous strands measuring 14,000 yards to the pound, the fibers are furnished in four screen sizes ranging from 1/32 to 1/4 inch in maximum length.

Ferro's system of quality-control checks will be used to maintain uniformity of product, according to William G. Cole, Jr., divisional manager. He also reported that fibrous-glass mat sales broke all records in the first quarter, and show promise of continuing at this level throughout the year.

New Cyanamid Facilities

Special facilities for producing new products to meet medium-scale demand have been installed at American Cyanamid Co.'s plants in Bound Brook and Warners, N. J. Larger than pilot plant facilities, they offer the advantages of obtaining a sounder appraisal of market potentialities before plant expansion, and the resolving of technical problems not encountered at the research and pilot plant level.

The Warners installation includes general manufacturing facilities, while equipment for hydrogenation and other high pressure reactions is available at Bound Brook. More than 20 derivatives of acrylonitrile, as well as other new products, are ready for production in the new facilities.

Mylar film used as telephone wire insulation

Uses Mylar as Wire Insulator

Production rate of telephone switchboard wire by Stromberg Carlson Co., Rochester, N. Y., has reportedly increased by 35-46% with the use of Mylar polyester film as a primary insulating material. A product of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., the film, in tape form, is said to have twice the tensile strength of the old insulation, but only half its thickness.

Vast expansion and modernization programs presently being undertaken by the nation's telephone companies have brought on increasingly heavy demands for the wire. With previously used insulating material and existing equipment, the wire could not be produced in sufficient quantities to meet these demands.

In addition to permitting faster production, Mylar reportedly contributes such superior properties as mechanical strength, long term heat resistance, high dielectric strength, and chemical inertness. As shown in the accompanying illustration, the new tinned-copper wire has a covering of Mylar, one of cotton yarn, and an outer coating of flame-resistant lacquer. The tape can also be made as thin as 0.25 mils, thus providing considerable space savings.

Plastic Tooling Saves $60,000

A $60,000 labor saving resulted from a single phase of the plastic tooling program undertaken by the automotive body division of Chrysler Corp., Detroit, Mich. This was shown in a time-cost study on prototype engineering for the 1955 Plymouth and for parts and panels of other Chrysler cars.

Phenolic hammer forms, stretch forms, hydroform, and draw dies were used to supplement or replace conventional metal and wood tools used in metal forming. Phenolic foam reduced the weight of tools and conserved materials costs. The disclosure appears in the current issue of *"The Marblette Mirror,"* a company publication issued periodically by Marblette Corp., Long Island City, N. Y., suppliers of the phenolic casting resins and cast epoxy surfacing used in the operation.

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Bolta Introduces Vinyl Foam

A vinyl foam material, reportedly having the same cushioning action as foam rubber, has been introduced by Bolta Products Division, General Tire & Rubber Co., Lawrence, Mass. Designated Fashion Foam, the new material can be used directly under vinyl sheeting, unlike foam rubber, and is fire-resistant.

Heat-sealable to almost any fabric, the foam has uniform compressibility and will not sag, lump, or crumble. Softness can be controlled by varying the density, which is approximately 50% that of foam rubber. Thickness from $\frac{1}{16}$-4 inches are currently being produced, and the material is available in any desired color.

Bjorksten Completes Tenth Year

On completing its tenth year of sponsored industrial research, Bjorksten Research Laboratories, Madison, Wisc., has issued a folder entitled "Ten Years of Progress—Plans for the Future." Presented in news release form, the subject matter includes a summary of accomplishments and plans for the future in sixteen fields of endeavor.

Among the highlights in Bjorksten's decade of activity are such contributions to the fields of plastics as the development of a transparent protective coating for polystyrene; an adhesive for Pittsburgh Plate Glass Co.; a stabilizer for Sharples Chemicals, Inc.; antistatics for Monsanto Chemical Co.; and glass-reinforced vinyl laminates. During research on the latter it was discovered that certain silicon compounds could be made elastomeric with a silicon content as low as 0.5%. This led to the development of a rubber-like product with complete ozone resistance, and both solvent and high-temperature resistance equalling or exceeding that of more expensive fluoro elastomers.

Other phases of activity led to patents in the transistor field, and corrosion prevention by electrochemical means. Future plans include silicone stabilizer research and the development of fire-retardant reinforced plastics, laminated plastic films, and waterproofing agents.

Monsanto Plant Safety Awards

The Texas City plant, winner among the large plant group, currently has operated 505 days for a total of 3,400,745 man- the best plant safety records. Monsanto's overall accident frequency rate was 1.14 major injuries per million man-hours, as without a major injury.
compared with the latest National Safety Texas, plant and the Montreal plant of top safety record among the small plants industry as a whole.

Monsanto Chemical Co.'s Texas City, rate for the chemical industry, and 7.44 for Monsanto Canada Ltd., were declared the hours without a major injury. Montreal's Council figures showing a 4.53 average showed 424 days and 267,675 man-hours 1954 winners of the president's trophies for

Offers High Polymers Course

An intensive course for scientists and engineers on the properties and structures of high polymers in solution will be given by the University of Michigan, Department of Chemical and Metallurgical Engineering, Ann Arbor, Mich., July 18-23.

Such subjects will be covered as the basic concepts of the structure and configuration of large molecules; behavior of high polymers in solution; experimental measurements, including those for viscosity, light scattering, infra-red absorption, sedimentation and diffusion, and osmotic pressure; and the interpretation of data.

Lectures, discussions, and laboratory work will be conducted by the following: L. M. Hobbs, associate professor of chemical engineering, University of Michigan, and director of Michigan-Memorial Phoenix Project on Elastomers; F. Bueche, associate professor of physics, University of Wyoming; L. H. Cragg, professor of chemistry, Hamilton College, McMaster University; Samuel Krimm, assistant professor of physics, University of Michigan; Robert Simha, professor of chemical engineering, New York University; and S. G. Weissberg, chemist, National Bureau of Standards.

Synthane Wins Safety Award

The National Safety Council's Award of Merit was presented to Synthane Corp., Oaks, Pa., for achieving a safety record 89% better than the average for the plastics industry. Since the company maintains a fabricating set-up as well as materials manufacture, safety entails both the problems inherent in a machine shop and those of a manufacturing plant.

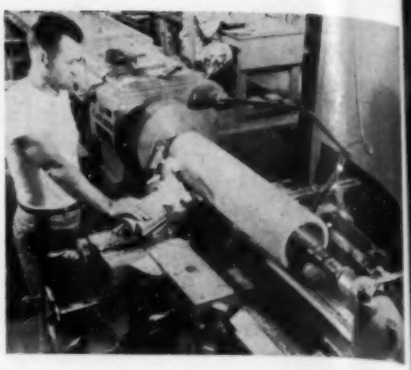
Synthane's accident frequency rate for the years 1951-1953 was 4.0 with a severity rate of 0.14, as opposed to the plastics industry averages of 8.6 and 0.73, respectively. In 1954, the company reduced these figures to a new low of 0.7 frequency and 0.01 severity, a fitting climax to its 25th anniversary year.

The safety record is attributed to equipment maintenance and the retaining of a licensed safety engineer in an advisory capacity. Other factors include the choice of a color scheme designed to minimize eye fatigue; an intricate dust removal system; and the maintenance of its own fire department and dispensary.

Bakelite Opens Packaging Lab

A laboratory for plastics packaging research has been opened by Bakelite Co., at their plant in Bound Brook, N. J. The new facility will concentrate on practical packaging problems involving the use of Krene vinyl film, and will explore the possibilities of new product development.

Programs already underway include horticultural and food technology, mechanical packaging operations, printing on plastics, properties of films and packages, and consumer packaging. Research grants to colleges and other laboratories for the study of a particular phase of packaging are being employed to extend the scope of these activities.



Lathe Grinding of Laminated Plastic-Covered Rolls for Tin-Plating.

Plastics Replace Rubber in Rolls for Tin Plating Mills

Thermosetting laminates used as coverings for steel rolls have reportedly improved the quality of tin plate and increased production at tin plating mills. The rubber-covered rolls previously used had required resurfacing approximately every 30 days due to moisture, abrasion, elevated temperatures, acids, and the high speeds used (up to 4100 feet per minute) in high-gloss polishing.

Additional complications were caused by abraded particles of rubber acting as insulators against the electrolytic deposition of soluble tin, and imbedded metallic chips scratching or scoring the thin surface coating. Replacement of any single roll during a plating run will shut down the entire line for nearly four hours, with resultant production lag.

A special resin-treated fabric, said to insure greater penetration of filler materials, was developed by Synthane Corp., Oaks, Pa., utilizing several types of thermosetting resins. This material was wound on the rolls, which had been preheated to 250° F., and oven cured at 300° F. to insure complete polymerization and fusion of the layers. Following cure, the rolls were trimmed and lathe-turned to the exact dimensions specified by Steel Plant Equipment Corp., Pittsburgh, Pa.

Returned to service, Synthane-covered rolls reportedly achieved an operating life more than three times that of the rubber-covered rolls. Bridle, insulated, and hold-down rolls showed acid resistance and a surface density which resisted abrasion. By overcoming boor edge cutting and gouging, the laminate-covered rolls also eliminated excessive vibration and chatter, two of the most destructive factors in high speed tin-plating operations.

Loewy Designs Polyester Awning

A new fiberglas-reinforced plastic awning, designed by Raymond Loewy Associates, will soon be placed in production by franchised manufacturers of the Ray-O-Lite Corp. of America, Atlanta, Ga. It features a long low horizontal design with curved lines and a casing of aluminum, all intended to create a modern finish completely devoid of exposed edges.

DuPont "Freon" Research Lab

Ground has been broken for the half-million-dollar "Freon" laboratory being built by E. I. du Pont de Nemours & Co., at Chestnut Run, Del. Scheduled for completion in early 1956, the new one-story unit will house the office and laboratories of the "kinetic" chemicals division, presently located at the company's Jackson laboratory, Deepwater Point, N. J.

"Freon" fluorinated hydrocarbon compounds find applications in the refrigeration, aerosol, plastics, and miscellaneous fields. New laboratory facilities will include two-man labs, aerosol loading labs, and a refrigerant evaluation and special test area, as well as office space for a supervisory staff. Separate facilities will be devoted to product development and evaluation, new methods and equipment testing, and technical service-sales training.

The first floor is to be constructed as a wing of the newly authorized $2,750,000 rubber chemicals research laboratory. It represents the fourth major expansion of the "kinetic" chemicals division in the past 1½ years. A $2,000,000 construction program at its Carney's Point, N. J., and East Chicago, Ind., plants was completed early last year, and construction of a new plant for the manufacture of "Freon-22" monochlorodifluoromethane near Louisville, Ky., is scheduled for completion early next fall. Recently, plans for still another unit at Antioch, Calif., were announced.

Cyanamid Making Acrylonitriles In Medium-Scale Quantities

The installation of special facilities for the intermediate commercial production of more than 20 derivatives of acrylonitrile, as well as other new products, at its Bound Brook, N. J., and Warners, N. J., plants has been announced by American Cyanamid Co., New York, N. Y.

The new installations are intended to supply these products to consumers in larger than pilot plant but smaller than full-scale commercial quantities. This will allow other industrial companies to proceed with their own development programs with assurance of adequate supplies, Cyanamid declares. It will also broaden Cyanamid's production experience with these chemicals as a prelude to the eventual construction of commercial plants.

Other advantages of this intermediate production technique are said to be the shortening of time required to bring a product from the research laboratory into profitable commercial production, the permitting of important economies in introducing new products to industry, and the minimizing of management's risk when it decides on plant additions to produce new products.

Technical snarls that are not revealed in pilot-plant production, but that may crop up in large-scale manufacture, may possibly be discovered, the company asserts. Also, a sounder appraisal of market potentialities is brought closer with medium-quantity output.

The Warners installation includes general manufacturing facilities, while equipment for hydrogenation and other high pressure reactions is located at Bound Brook. Cyanamid is currently producing acrylonitrile at its Fortier, La., plant.

Thiokol Reopens Polymer Plant

Due to an increased demand for polysulfide liquid polymers, Thiokol Chemical Corp., Trenton, N. J., has reopened its Moss Point plant. The materials are oil- and solvent-resistant elastomers used as sealants and adhesives for aircraft fuel cells, machine components, and electrical parts, and for caulking ship decks.

The plant is designed to produce large quantities of polysulfide polymers, starting with the basic chemical ingredients, which include ethylene oxide, sulfur, and caustic soda. During the partial shutdown, production of the monomer was continued in order to supply raw materials for the Trenton division; however, with the reactivation of the polymerization units, polysulfide polymers will be produced at Moss Point as well as at Trenton.

Ohio-Apex To Erect Dapon Plant

Construction of a new plant for the manufacture of diallyl phthalate prepolymer has been initiated by Ohio-Apex Division, Food Machinery & Chemical Corp., at the site of their present operations in Nitro, W. Va. Trademarked Dapon, the new resin has been in pilot plant production for approximately a year. Sales and distribution of the resin will be handled through the company's existing trade outlets.

Marking the entrance of Ohio-Apex into the resin production field, Dapon is expected to find application in the manufacture of electrically-resistive molding powders and decorative glass-reinforced laminates. Previously, the company's products had been restricted to plasticizers and inorganic chemicals.

In Brief . . .

National Distillers Products Corp., New York, N. Y., has announced that all chemical operations of the company will be conducted by their U. S. Industrial Chemicals Co. division. The change is primarily of company name and internal organization; U. S. Industrial Chemicals Co. formerly being part of the chemical division of National Distillers.

C. J. Osborn Co., New York, N. Y., has been appointed exclusive United States distributors for Sachtleben Co., Cologne, West Germany, manufacturers of zinc sulphide, 60% concentrated zinc sulphide, and precipitated blanc fixe white pigment for rubber, plastics, and paint compounding. Osborn maintains laboratory facilities in Linden, N. J.

National Carbide Co., a division of Air Reduction Co., Inc., New York, N. Y., has announced the availability of a new 16 mm color film, entitled "Fiery Magic," which demonstrates the steps in the manufacture of calcium carbide and portrays the varied uses of acetylene.

Thiokol Chemical Corp., Trenton, N. J., has granted a total of $5,000 to Drexel Institute of Technology, Philadelphia, Pa.; Brooklyn Polytechnic Institute, New York, N. Y.; and Rider College, Trenton, N. J., for the encouragement of advanced training for scientific and business personnel.

Hooker Electrochemical Co., Niagara Falls, N. Y., and Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y., have announced through their boards of directors the approval of a formal agreement for consolidation of the two companies, subject to approval by their stockholders. A decision should be reached at a special stockholders' meeting scheduled for April 28.

Lincoln Plastics Corp., has moved its executive offices to its new Eastern plant at 13 Marshall St., South Norwalk, Conn. The plant itself is equipped with the latest type injection molding presses, from small automatic types to large preplasticizing presses of 40-ounce capacity.

Rohm & Haas Co., Philadelphia, Pa., has announced price reductions of approximately 10% and 12%, respectively, for clear and colored Plexiglas R cast acrylic sheet. Three thinner gages (60, 80 and 100 mils) have also been added. Prices for acrylic molding powders have been reduced about 5%.

Baldwin-Lima-Hamilton Corp., Philadelphia, Pa., will distribute in this country the line of fatigue testing equipment manufactured by Carl Schenk, Darmstadt, Germany, and has granted the German firm the European sales rights to Baldwin SR-4 bonded resistance wire strain gages, SR-4 devices, testing machines, and associated instrumentation.

Monsanto Chemical Co.'s plastic division, Springfield, Mass., has announced the availability to clubs, schools, and stores of two new 16-mm. color films entitled, "Have a Hobby," and "Children's Party." The former demonstrates how to assemble plastic models of everything from antique housewares to jet aircraft, and the latter suggests how to wrap gifts with decorative plastic materials.

Dow Chemical Co., Midland, Mich., has announced the availability of colored Styrofoam in two forms; packaged 2- by 12- by 36-inch boards, and unpackaged rough planks approximately 4- by 13- by 108-inches in size. Colors include red and shades of green.

(Cont'd. on page 264)

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News from Abroad

Plastics in Austria

The manufacture of plastic floor coverings, draperies and wallpapers is making headway in Austria. Semperit Oesterreisch-Amerikanische Gummiwerke A. G., Vienna, the leading rubber manufacturer in Austria, has been producing plastic goods for some time now, and among its specialties are polyvinyl runners. These are available in widths of 85 and 100 cm. (about 34 and 40 inches, respectively) and in a variety of plain colors, as well as marbleized and grained effects. The runners are marketed under the name Terravinyl.

Another Austrian firm has launched plastic-coated wallpapers that are claimed to be really washable. A wall covered with Lavacell, as the product is called, was reportedly cleaned with soap and a brush 150 times without harm to the surface. Besides being waterproof, Lavacell, which has a coating of PVC on a wallpaper backing, is claimed to be highly lightfast and resistant to abrasion and scratching.

Pechiney's Research Center

Société Pechiney et Cie, Paris, France, has recently completed the establishment of a research center at Aubervilliers, not far from Paris. The center, built on a plot of 1½ hectares (about 3½ acres) to allow for future expansion, includes a reception room, lecture hall, offices, library, and five floors of laboratories. The laboratories are equipped for work on organic, mineral, and macromolecular chemistry, as well as physical and physico-chemical determinations. The physical research laboratories are provided with special high precision instruments, and are open to all investigators as well as factory research workers. A separate section is designed for pilot setups for various purposes. In addition, there are two laboratories for testing finished products made at the company's development plant, as well as by converters using the company's materials. The staff of 200 includes 50 engineers and 100 chemists and assistant chemists.

Japanese Plastics Industry

Plastics production in Japan is now said to approximate 90,000 tons annually. Some 34,831 metric tons of plastics materials were produced during the first six months of 1944, in addition to 8,000 tons of resin coatings and 1,000 tons of saran. Production figures for 1952, 1953, and the first half of 1954 are given in the following table:

(All Figures in Metric Tons)

	Total 1952	Total 1953	First-Half 1954
Cellulosics:			
Cellulose nitrate	6,341	6,021	3,456
Reprocessed	1,469	1,400	839
Cellulose acetate	103	235	101
Phenolic & other tar acid resins:			
Molding materials	4,124	5,546	3,550
Laminating materials	1,446	1,902	1,244
Other	1,298	1,649	959
Urea molding powders	6,594	8,299	4,807
Adhesives	5,531	8,890	6,459
Other	699	741	635
Melamine resins	174	753	512
Vinyl polymers & copolymers	8,491	13,857	10,308
Acrylic polymers	350	593	399
Alkyd resins	1,132	1,788	1,537
Polyester resins	—	—	15
Silicone resins	—	—	10

There are 232 molders in Japan, with a total capacity of 2,652 ounces. Of this group, 100 are in Tokyo, 21 in Osaka, and 24 in Nagoya. Machines in use include 458 of Japanese construction and 88 made abroad. Use of injection molding machines has shown a steady increase. In 1949 there were 28 such machines in use, and this number increased to 69 in 1951, 147 in 1952, 444 in 1953, and 557 in 1954. Monthly consumption of molding materials is said to be 294 tons. Of this total, 204 tons are polystyrene, 20 are acrylates, 9 are PVC, 38 are acetates, 22 are polyethylene, and one is nylon.

There are 11 manufacturers of PVC in Japan. The most important of these firms and their monthly productions are: Nippon Geon Co., Kaubara, 370; New Nittitsen, Minamata, 270; Kanakura, Osaka, 240; Mitsui Chemical, Nagoya, 225; and Monsanto, Kawasei, 170. Estimated end-use consumptions of PVC in 1953 were 6,880 metric tons in film; 3,763 tons in sheeting; and 2,480 tons in artificial leather. Corresponding consumption figures for 1952 were 2,470 tons, 2,082 tons, and 760 tons, respectively.

Japan had been importing about 100 tons a month of polyethylene from the United States. In 1954, Sumitomo Chemical, Niihama, began pilot-plant production of the resin at a rate of three tons per month, and expects to increase this output gradually to 100-200 tons per month. At present, ethylene is produced by the dehydration of alcohol, in accordance with the British method. Other Japanese firms are also planning to make polyethylene.

Two firms are manufacturing acrylic resins: Mitsubishi Kwasei Co. and Tokwasei Co. Production of acrylic monomer totaled 492 tons in 1952; 354 tons in 1953; and 598 tons during the first half of 1954. Saran output by Osahi-Dow Co. is reported to be 100 tons a month, and three other firms are also making this material. Polyvinyl alcohol production is 460 tons per month, with Kurashiki Rayon producing 320 tons per month and Nippon Gosei making 140 tons per month.

Imports of all plastic materials, except phenolics, vinyls, and cellulosics, rose from 1,030 tons in 1952 to 2,683 tons in 1953 and 2,841 tons during the first half of 1954. Imports of vinyls declined from 590 tons in 1952 to 290 tons in 1953 and 83 tons during the first half of 1954. Exports of vinyl resins, during the first six months of 1954, increased to 208 tons from a total of 329 tons in 1953 and only 40 tons in 1952.

Hazards with Isocyanates

Special precautions are required by those who work with polyurethanes (the addition products of isocyanates and hydroxyl polyesters), a West German government official recently warned. If not carefully handled, the isocyanates have been found to be particularly harmful to workers prone to bronchial catarrh. In one instance cited, when the pontoons of Rhine bridges were being made unsinkable by the introduction of Moltoprene in the pontoon chambers, 10 workers engaged on this job became ill within three months. Moltoprene, a foamed product of Farbenfabriken Bayer A. G., Leverkusen, is made by combining Desmodur isocyanates with Desmophen hydroxyl polyesters. When handling the Desmodurs or the cleaning tools used to handle them, protective spectacles, masks, and gloves should be worn. Care must also be taken to avoid inhaling the vapors released in the preparation of polyurethane lacquers and finishes.

International Plastics Days

The third series of International Plastics Days and the second National Congress of the U.S.T.M.P. were held in Paris, France, concurrently during March 22-26, 1955. The sessions of the International days were arranged under five groups: research, production, utilization, application, and economy. Four lectures were presented in plenary sessions; and a total of 70 papers were read at the various group meetings.

The National Congress of the U.S.T.M.P. held meetings of its various technical committees during March 24-26, when in addition to five plenary lectures, numerous papers were offered touching on a wide variety of topics including raw materials and processing, as well as general problems pertaining to commerce, finance, organization, wages, labor relations, safety, and hygiene.

All the papers and lectures presented at the International Days will be published in a special issue of the *Industrie des Plastiques Modernes*.

Plastics in Norway

Norway is one of the various smaller countries that have been contributing their share toward the rapid development of the plastics industry in Europe since the end of the war. In 1940, there were only about 10 factories, employing around 100 persons in all, engaged in compression molding, chiefly of Bakelite. Today, the number of factories producing plastic articles is put at 70, and their annual consumption of thermoplastic and thermosetting materials is estimated to be between 2,000 and 3,000 tons. Plant equipment on the whole is very up-to-date, especially for injection molding, and a variety of goods is produced for the domestic market and even to some extent for export.

Local firms supply some of the basic and semi-finished materials for the industry, but a substantial proportion must still be imported. The very prosperous carbomide resin industry in Norway relies on urea from Norsk Hydro, which has a productive capacity of about 10,000 tons of urea annually, and formaldehyde from Norske Kunstharpikser A/S, Lillestrom, which produces about 5,000 tons of formaldehyde annually, mainly from imported methanol. The latter firm also produces about 3,000 tons of synthetic resins mostly for varnishes and adhesives, as well as resin for molding powders.

Another supplier of urea and formaldehyde resins for varnishes and adhesives is A/S Resine, of Frederikstad. Wm. A. Mohn & Son, Bergen, has developed a protein-based molding powder, "Monoplast," from fish waste; this material is said to have electrical properties superior to those of phenol-formaldehyde resins, while its mechanical and water resistance is at least equal to those of the usual molding powders.

Advances have also been made in the field of thermoplastic powders. Heroya Elektrokjemiske Fabrikker A/S (H.E.F.A.) has been producing about 1,500 tons annually of PVC from acetylene and hydrochloric acid obtained from its own installations; however, the active demand has apparently decided the firm to raise output to 2,000 tons annually before long.

Plasticizers, dibutyl phthalate and dioctyl phthalate, are produced by Norsk Spraengstofindustrie A/S, and similar plasticizers as well as cellulose acetate are soon to be made by A/S Borregard.

The industry has its own association, Forening for Norsk Plastindustrie, 53B Munkendam Veien, Oslo, which participates in all technical and economic questions, and cooperates with other similar institutions all over the world.

British Trade in 1954

New records in production and exports of plastics were established by the United Kingdom in 1954. Output is estimated to have reached 240,000 tons, substantially above the 1953 level, with thermoplastics representing more than half the total. The vinyls at around 60,000 tons were quantitatively the most important and will make further progress in 1955, for manufacturers are planning expansions which will add several thousand tons to the output by the end of this year. At that, supply is not expected to cover the whole demand which has been stimulated considerably by the decision of the authorities to replace existing old-type conveyor belting in coal mines with modern vinyl belting.

Marked increases were also noted in the output of polystyrene, cellulose acetate powder, and, more particularly, polyethylene. Production of the latter is advancing by leaps and by bounds. Estimated at 12,000 tons in 1953, it jumped to about 20,000 tons in 1954 and is expected to reach 35,000 tons by the end of this year, with the prospect of still further expansion to 55,000 tons by the end of 1957.

Thermosetting resins did well, too; phenolics recovered from their set-back in 1953 with production about 33% higher than in that year and close to the peak of 1951. Amino plastics similarly improved, with outputs 25% higher than in 1953.

Exports of plastics in 1954 reached the all-time high of 70,126 tons, beating the previous record of 1953 by over 13,500 tons, or almost 25%. The increases were noted in practically every line, with the vinyls leading. Australia continued to be Britain's best customer in spite of a rapidly developing home industry; South Africa came next. In Europe, The Netherlands ranked as the most important customer; the Scandinavian countries continued to be satisfactory buyers.

The current year started auspiciously, with exports in January at 7,187 tons, one of the highest monthly totals ever reported, and 1,350 tons above the January 1954 figure. Bigger sales of vinyls, polystyrene molding powders, and semi-finished acrylics accounted for practically the whole increase. Exports to South Africa were more than double, and those to Europe nearly double what they had been in the beginning of 1954. Canada and Germany participated in the increased imports, but the United States lagged somewhat in this respect.

Australian Plastics Fair

Town Hall, Sydney, Australia, has been chosen as the site for "Plastics Fair, 1955," which is scheduled for July 13-21. Jointly sponsored by the Plastics Institute of Australia and the Australian Plastics Journal, the fair will run simultaneously with Plastics Week, and should serve as a focal point to highlight the latter event.

Space has been provided for more than 60 display booths and exhibits. In addition to plastics raw materials and processing machinery, the following themes will be featured: plastics in building and engineering, in radio and electricity, in the home and garden, in display and advertising, in play and relaxation, and in fabrics and fashions.

German Producers of Steel Tubing Enter Plastics Field

A group of German manufacturers of steel tubing is understood to have formed a joint committee to study the possibilities of plastic tubing. This is a further instance of the growing interest of the German steel industry in plastics first made evident by the acquisition in 1953 of a 52% share in Sudwest-Chemie G.m.b.H., Neu-Ulm, by the Mannesmann A.G., the largest producer of seamless tubing in Germany, which thereby entered the plastics field.

Plastics in Canada, 1954

With the exception of 1952, each year since 1948 has seen a substantial increase in Canadian output of plastic materials. In 1948, 12 factories employing 1,149 persons manufactured materials valued at $16,440,747. In 1953, there were 19 factories employing 2,160 persons and making materials valued at $44,451,882. Final figures for 1954 are expected to show for materials manufactured a total valuation of about $46,000,000.

Progress in 1954 was noted chiefly in the production of polyethylene and nylon. DuPont began operation of its nylon intermediates plant at Maitland, Ont., and Canadian Industries, Ltd., in the fall began production of polyethylene at its new plant in Edmonton.

According to available figures, 1954 Canadian output of plastics, in pounds, was as follows:

Polystyrene	37,000,000
Vinyl chloride & copolymers	15,000,000
Phenolic molding powders	22,000,000
Adhesives	15,000,000
Polyethylene	3,000,000
Cellulose acetate flake	30,000,000
Polyester resins	2,000,000

From these figures, it is obvious that polystyrene is the most important Canadian plastic. Most of the output of this material is exported, and this output is only about half the actual production capacity. The large output of cellulose acetate flake also is chiefly exported, mainly to Europe and South America for spinning into filaments.

Calculated imports, in pounds, of plastics materials into Canada in 1954 are as follows:

Polyethylene	9,000,000
Polystyrene crystal	900,000
Copolymers	2,400,000
Alkyd resins (for paints)	8,000,000
Polyvinyl chloride	8,000,000
Vinyl acetate monomer	2,000,000
Vinyl chloride, semi-finished	170,000
Cellulose acetate	666,000
Film & sheeting	3,500,000
Phenol-formaldehyde	2,000,000
Urea & melamine	5,640,000
Urea adhesives	4,000,000
Phenolic laminates	533,000
Tar acid resins (adhesives)	8,000,000
Ester gums	3,000,000

The United States supplies by far the greater part of these imports, with Britain the next largest supplier. Some Italian cellulose acetate molding powder and vinyls have begun to appear in Canada, and Germany has started to compete with the United States in the rather limited Canadian market for acrylics.

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NAMES in the NEWS

Raymond J. O'Hara

Raymond J. O'Hara has been appointed chief chemist for Synthetic Products Co., Cleveland, O. He has had over 10 years' experience in the development and application of vinyl stabilizers and metal-organo compounds for the plastic, paint, and grease industries.

W. J. Vogel has been named general sales manager for the plastics division of Reynolds Metals Co., Richmond, Va. He will maintain offices at 400 N. Michigan Ave., Chicago, Ill.

A. Eugene Schubert has been named manager of engineering, chemical materials department, General Electric Co., Pittsfield, Mass. He joined the company in 1942 and became the head of the chemical process section of its research laboratory in 1945.

Louis A. Fisher has been elected a director of The Eagle-Picher Co., Cincinnati, O. He is president of Fabricon Products Division and a vice president of Eagle-Picher.

T. B. Moore has been appointed assistant superintendent of the shipping, order, and traffic departments at Carbide & Carbon Chemicals Co.'s plant in South Charleston, W. Va. He formerly served as assistant superintendent in charge of fine chemicals and the Lower Blaine Island area. **Maxwell Hill, Jr.,** succeeds **Mr. Moore.**

C. C. Fuller has been named vice president in association with the sales management staff of Foxboro Co., Foxboro, Mass. Also advanced were **H. O. Ehrisman** to general sales manager and **J. J. Burnett** to field sales manager. **C. E. Sullivan,** a vice president, has retired from the position of general sales manager but will continue to serve in a consulting capacity.

Frank H. Smart has joined Harchem Division, Wallace & Tiernan, Inc., Belleville, N. J., as assistant to the director of sales with special reference to plasticizers and sebacic acid.

Wm. Howlett Gardner has been transferred from the new products division of National Aniline Division, Allied Chemical & Dye Corp., New York, N. Y., to the company's chemical sales department where he will serve dually as writer of technical literature and technical sales representative.

Donald R. Fegley has joined Reed-Prentice Corp., Worcester, Mass., as chief engineer. He formerly served as chief engineer for Consolidated Molded Products Corp.

Green's Studio

Lloyd J. Oye

Lloyd J. Oye has been appointed national director of marketing for Rezolin, Inc., Los Angeles, Calif. Former manager of field engineering for Magnaflux Corp., he will direct a special customer service program for Rezolin's Toolplastiks.

Donald F. Pethybridge has been appointed chief chemist for Reed Plastics Corp., Worcester, Mass. He has served the textile and thermo-plastics fields for many years.

A. Briggs Bonneville has been appointed assistant director of product development for Monsanto Chemical Co.'s plastics division, Springfield, Mass. He will be responsible for the commercial evaluation of new polymers, and the development of new applications for existing products.

DeWitt L. Shelly has been appointed manager of the newly formed special products group, Air Brake Division, Westinghouse Air Brake Co., Wilmerding, Pa. The new group will specialize in quality controlled manufacture and assembly, and testing of general industrial apparatus and components.

Harry M. Zimmerman

Harry M. Zimmerman succeeds **Robert S. Price** as general manager of the plastics division, Seiberling Rubber Co., Newcomerstown, O. He formerly served as development engineer and as technical service and sales representative for the B. F. Goodrich Chemical Co.

T. R. Miller has been named director of Carbide & Carbon Chemicals Co.'s plant laboratories in South Charleston, W. Va. **Dr. Miller** has served with the company since 1940.

John M. Wilson has been appointed chief engineer for the development and design division, engineering department of Minneapolis-Honeywell Regulator Co.'s Brown Instrument Division, Philadelphia, Pa. He formerly served as chief electrical engineer for the parent firm in Minneapolis.

Dow Chemical Co., Midland, Mich., has announced the following promotions within the plastics technical service department:

William E. Brown, Robert C. Cottrell, Joseph Eveland, F. Jack Gibbs, Maurice Q. Tessin, and **Harold J. Waite** from plastics field development engineers to plastics customer service engineers.

Ted C. Broadwell, Casimer A. Burczyk, and **James L. Forse** as plastics field development engineers.

John C. Cotner has resigned as president and general manager of Hydraulic Press Mfg. Co., Mount Gilead, O., after having headed the company for five years. He remains as director.

Alvin O. Fuhrmann has been appointed national aircraft sales manager of the adhesives and coating division of Minnesota Mining & Mfg. Co., St. Paul, Minn.

"JUDGE" of Good Pictures

George W. Naylor

George W. Naylor, recently named manager of the chemical division's international department, becomes divisional vice president of Koppers Co., Inc., Pittsburgh, Pa. He has had broad experience in development, sales, service, and control work both in this country and abroad.

Arden Photographs

Max Wohlleben

Max Wohlleben has been named chief engineer and sales director for Newark Die Co., Newark, N. J. Formerly chief designer, his new duties will include sales, customs service, estimating, and engineering for plastic molds.

Charles L. Becker, Jr., has been appointed to the newly created post of manager of customer relations for the Textileather Division, General Tire & Rubber Co., Toledo, O. His duties will include coordination of advertising and sales promotion programs, training of sales personnel, and preparation of sales aids and manuals.

Lloyd C. Adam

Lloyd C. Adam has been appointed sales manager in charge of the rubber and plastics machinery division of Erie Engine & Mfg. Co., Erie, Pa.

John M. Wells has been appointed Boston district sales manager for the Sylvania Division, American Viscose Corp., Philadelphia, Pa. Formerly sales supervisor for Ohio, West Virginia, and Western Pennsylvania, **Mr. Wells** succeeds **Henry W. Dearborn,** whose retirement becomes effective July 1.

R. K. Buffington has been appointed sales manager for General Plastics Corp., Los Angeles, Calif. He formerly served as assistant sales manager for the Royalite Division, U. S. Rubber Co.

Hugh O'Reilly and **R. M. Lawlor** have been appointed Mid-Atlantic sales representatives for Chicago Molded Products Corp., Chicago, Ill. They will handle sales and service both for Chicago Molded's custom molding operation, and for the Campco Division's thermoplastic sheeting. They will have their headquarters in Bryn Mawr, Pa.

Henry R. Lasman has been added to the technical staff of National Polychemicals, Inc., Wilmington, Mass. Formerly associated with a number of Canadian and European firms, Mr. Lasman will direct National's newly-erected rubber and plastics laboratory.

George S. Hannaway has been appointed director of marketing for the overseas division of Monsanto Chemical Co., St. Louis, Mo. He succeeds **J. G. MacDermot,** who becomes assistant general manager for the division. Both men have seen considerable service with Monsanto's foreign departments.

Charles A. Cary has retired as vice president and member of the executive committee of E. I. du Pont de Nemours & Co., Wilmington, Del., after 37 years of service. He retains his position as a member of du Pont's board of directors.

Joseph C. Davidson, vice president of Union Carbide & Carbon Corp., New York, N. Y., was presented with the honorary degree of Doctor of Science by the University of Southern California on April 22. **Dr. Davidson** was cited for "outstanding leadership in the fields of science and business administration."

Howard Gorman and **Richard Glenn** have been appointed cellophane sales representatives for Sylvania Division, American Viscose Corp., Philadelphia, Pa. **Mr. Gorman** will cover the Alabama, Western Georgia, and Southeastern Tennessee area, and **Mr. Glenn** the Southern Chicago territory.

Herbert Lorenz, 299 Madison Ave., New York, N. Y., has been appointed export representative for Plastics Color Co., Summit, N. J. **Mr. Lorenz** formerly served with American Cyanamid Co., and was president of the South American Minerals & Merchandise Corp.

Charles Uht

Augustus B. Kinzel

Augustus B. Kinzel has been elected vice president in charge of research for Union Carbide & Carbon Corp., New York, N. Y., succeeding **George O. Curme, Jr.,** who is retiring as vice president of the firm but will continue as a director.

OBITUARY

Norman J. Elder

Norman J. Elder, vice president and manager, calender division, Adamson United Co., Akron, O., and a member of the Editorial Advisory Board of PLASTICS TECHNOLOGY, died April 18 at Dayton Miami Valley Hospital, Dayton, O. His death was the result of an accident in a gymnastic exhibition at the Y. M. C. A. in that city.

Born August 15, 1917, at Carnegie, Pa., Mr. Elder was graduated from the University of Akron, receiving a bachelor's degree in mechanical engineering. He joined Adamson in 1946 after serving as assistant chief draftsman for Morse Instrument Co. from 1942-1944, and as a naval engineering officer from 1944-1946. He was made a vice president of Adamson in April 1954.

Mr. Elder was a member of ASME, the University Club of Akron, and the Ohio Society of Professional Engineers. He is survived by his wife, Irene, and three children.

Frank H. Kennedy

Frank H. Kennedy, founder and president of Electronic Wave Products, Inc., and Kennedy Industrial Coatings, Inc., New York, N. Y., died February 15, 1955.

A native of the Bronx, Mr. Kennedy was educated at Syracuse and Alabama Universities. He was active in several professional organizations, including the Society of Plastics Engineers.

Services were held at Campbell's Funeral Church in New York City, followed by interment in Woodlawn Cemetery, Bronx, N. Y. Mr. Kennedy is survived by his wife, Mildred, and two children, Karolyn and Frank, Jr.

Lawrence W. Seybold

Lawrence W. Seybold, former vice president, treasurer, and a director of Michigan Molded Plastics, Inc., Dexter, Mich., died March 11.

Born March 26, 1893 in Ann Arbor, Mich., Mr. Seybold served as general manager of the plastics division, Reynolds Spring Co., from 1924 until joining Michigan in 1940. He retired in 1953.

A memorial service was held at the Methodist Church in Dexter, followed by interment in Bethlehem Cemetery, Ann Arbor, Mich. Mr. Seybold is survived by his wife, Lois E., a daughter, and three grandchildren.

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New Materials

Plaskon Nylon Molding Compound

Large-scale production of a new type of nylon molding compound, Plaskon Nylon 8200, was recently announced by Barrett Division, Allied Chemical & Dye Corp., New York, N. Y. This nylon, also known chemically as type 6, is made by the polymerization of caprolactam monomer, and is a product of close cooperation between the Barrett, National Aniline, and Nitrogen Divisions of Allied. Barrett and Nitrogen supply the basic chemicals; National Aniline operates the nylon production facilities at Hopewell and Chesterfield, Va.; then Barrett takes over as the selling agent.

In addition to the standard mechanical, chemical, and self-lubricating properties of conventional nylons, the new material has four features that offer interesting new possibilities to molders and extruders. These features are: (1) relatively high molten viscosity, which largely eliminates leakage from nozzles and joints, and permits the use of blow molding; (2) controllable crystalline struction, providing a broad range of rigidity and toughness properties and, in thin sections, the manufacture of clear films; (3) outstanding moldability, permitting the molding of thick sections or large pieces with a minimum number of voids, and eliminating decomposition during the molding or extrusion cycle; and (4) ability to be color-blended before molding, or cold-colored after molding.

Properties of molded Plaskon Nylon 8200 are given as follows:

Tensile strength, psi.	12,000
Yield point, psi.	8,500
Elongation, %	300
Compressive strength, psi.	11,000
Impact strength, Izod, ft.-lbs./in. of notch	1.2
Flexural strength, psi.	10,000
Deformation under load, %	1.7
Heat distortion temperature, °F.	136
Hardness, Rockwell "R"	118
Specific gravity	1.13
Bulk factor	2.2
Water absorption, %	1.6
Flow temperature, °F.	419

The manufacture of high strength film and sheeting, blow molded bottles for chemicals, and the molding and extrusion of large and intricate shapes were among the applications predicted for the new material. In unoriented form, sheet made with the new nylon is suited for use as a laminating material with other plastics, papers, etc. Axial orientation improves the physical properties, and allows thin films to be used in the packaging field. Nylon bottles have been made with Plaskon 8200 on production type equipment, and have potentials for packaging chemicals and cosmetics. In addition, the new material can be used for current applications of nylon in industrial and consumer uses.

Readers' Service Item M-1

Super Dylan Polyethylenes

A series of temperature- and chemically-resistant polyethylenes offering rigidity, low temperature toughness, and a smooth, glossy appearance have been introduced by Koppers Co., Inc. Designated Super Dylan, the materials were developed by modifications of the basic European process to produce an unusual range of properties which are listed as follows:

Specific gravity	0.93-0.95
Tensile strength, psi	2,800-5,500
Elongation in tension, %	100-400
Stiffness modulus, psi	50,000-100,000
Impact strength, notched Izod, ft.lbs./in. notch	1-5
Unnotched Izod @ 21° C., ft.-lbs./in., min.	32
At —65° C., min.	32
Tear strength, lbs./in.	600-1,300
Hardness, Shore D	63-70
Crack resistance to detergent, 50° C., wks. min.	1
Dielectric constant, 80 megacycles	2.2-2.3
Dissipation factor, 80 megacycles	Below 0.0005
Melt index, gms./10 min.	0.1-4.0
Dimensional stability to steam, 10 min. @ 250° F., %	2-4
Brittleness temperature, °F.	Below —100
Flammability, in./min.	0.9-1.1
Deformation under load @ 50° C., %	0.05-0.40
Mold shrinkage, injection, in./in.	0.012-0.025

Among the possible applications of Super Dylan are "kid-proof" toys; kitchen ware which can be sterilized by boiling; pipe and fittings with burst strength around 1,025 pounds hydrostatic pressure; steering wheels; bottles and carboys; packaging films; washing machine agitators; refrigerator parts; and battery cases.

Super Dylan can be processed well within the normal operating ranges for polyethylene. Some mold shrinkage results, which, though less than regular polyethylene, may require other than polystyrene mold equipment. The material will mold around metal inserts. Heat sealing requires somewhat higher temperatures.

Readers' Service Item M-2

Samuel A. Musgrave

Experimental moldings of Super Dylan Polyethylene show a variety of applications

Mixed Sebacic Acid Plasticizer

A new base material for the production of vinyl plasticizers has been introduced by U. S. Industrial Chemicals Co., division of National Distillers Products Corp. Designated U.S.I. Isosebacic acid, the compound consists of mixed isomers of sebacic acid in approximately the following proportions: α-ethyl suberic acid 72-80%; α-α[1]diethyl adipic acid 12-18%; and sebacic acid 6-10%.

The new material, which has resulted from more than three years of research and 15 months of pilot plant development, is said to offer a plasticizer with excellent low-volatility, non-migration, and low-temperature characteristics. Other than vinyls, applications include production of polyamides; alkyd resin manufacture; synthesis of ester lubricants for jet aircraft; polyester resin production; and the synthesis of polyurethanes.

Availability is presently limited to laboratory and pilot plant quantities, obtainable from the U. S. I. market development department. Plans for a full-scale commercial plant are underway, capacity to depend on the outcome of current market evaluations. Tentative specifications are listed as follows:

Molecular weight	202.24
Combining weight	101.12
Minimum dicarboxylic acid content, %	98.5
Maximum volatile acid content, ppm	300
Moisture content, %	0.3
Ash content, %	0.1
Iron content, ppm	3
Iodine number	1
Color, A.P.H.A.	60
Melting range, °C.	68-74
Density, 80° C., lbs./gal.	8.55

Readers' Service Item M-3

Auxiliary Stabilizer

Advastab BA-13P, a complex organic barium compound for use as an auxiliary for cadmium and zinc stabilizers in the heat and light stabilization of vinyl compounds, has been introduced by Advance Solvents & Chemical Corp., New York, N. Y. Reported to contain no volatile solvents, the new product is a viscous liquid that eliminates fuming and other disadvantages connected with solvent evaporation during heat processing of the vinyl. In plastisol formulations, BA-13P is said to minimize viscosity build-up.

Suggested formulations for calendering or extrusion in a barium-cadmium stabilization system include 100 parts resin, 50 parts DOP, 1-2 parts BA-13P, and 1-2 parts cadmium stabilizer. In a barium-zinc system only 0.5 parts zinc stabilizer are recommended. Plastisol and special formulations using Advastab BA-13P are available from the company on request. Specifications are listed as follows:

Specific gravity @ 25° C.	1.13
Weight, lbs./gal.	9.45
Viscosity, cps.	1,000-1,100
Color, G.H.	6-7

Readers' Service Item M-4

Glass-Modified Phenolic Resins

A series of glass-reinforced phenolic molding materials has been developed by Rogers Corp. Presently available are two glass-and-cellulose materials, designated RM 4015 and RM 4030 and intended for heavy-duty industrial applications.

Marketed as sheets and blanked preforms, the materials reportedly lend themselves to standard molding operations, high speed tapping, and the molding-in of inserts. They can be formed in very shallow molds, as well as molds used for low bulk general-purpose materials.

Typical test results are listed as follows:

	RM 4015	RM 4030
Thickness, mils.	62	60
Density	1.45	1.56
Tensile strength, psi.:		
Lengthwise	19,000	22,000
Crosswise	13,000	13,000
Flexural strength, psi.:		
Lengthwise	33,000	38,000
Crosswise	20,000	26,000
Impact, notched Izod, ft-lb./in.:		
Lengthwise	3.9	7.0
Crosswise	2.7	4.8
Dielectric constant, 10^6 cycles	5.0	3.3
Power factor, 10^6 cycles	0.035	0.030
Water absorption, 24 hrs., %	0.6	0.5
Bulk factor	2:1	2:1
Dielectric strength, short time, volts/mil	775	775
Mold shrinkage, mils/in.:		
Lengthwise	1.0	0.9
Crosswise	3.0	2.6

Readers' Service Item M-5

Watson-Standard Plastisol

A free-flowing chemically-resistant plastisol, which can be converted by heat into a flexible, rubber-like coating for metal parts, has been introduced by Watson-Standard Co. Designated by the number 16-093, the material represents a basic formulation which would normally be modified to meet individual customer specification.

The plastisol is reportedly resistant to such corrosives as acids, alkalis, oils, greases, organic salts, and petroleum solvents. Specifications include a tensile strength of 1,800 psi. after cure, a durometer of 60-65 Shore "A", and a specific gravity of 1.2-1.25. The coating may be deposited in thicknesses varying from 1/32-½ inch, and the film itself is said to be smooth, dense, abrasion-resistant, and resilient.

Basically a dipping-type formulation, 16-093 is adaptable to either cold or hot dip technique. It can also be modified for slush or rotational molding. Applications include ducks, racks, tote baskets, tank linings, valve parts, and other metallic surfaces where chemical resistance is of prime importance. The plastisol is shipped at 100% solids, black in color unless otherwise specified.

Readers' Service Item M-6

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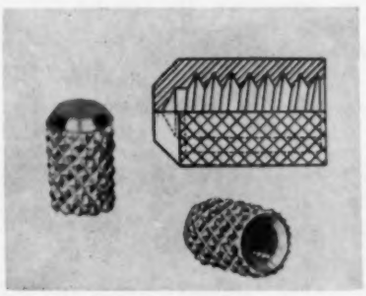

Yardley Threaded Aluminum Inserts for Molded Plastic Parts

Standardized Aluminum Inserts

Production of standardized aluminum inserts for molded plastics has been announced by Yardley Precision Products Co. The inserts are tapped to maximum depth with Class II threads in sizes from 4-36 to 12-24, meeting ASME specifications. The holes are then reamed to maintain exact tolerances, and to facilitate securing of the inserts on the locating pins.

The outside knurl is extremely coarse to afford holding power against high torque. Large and small quantities of these inserts are reportedly available from stock.

Readers' Service Item E-1

Model 79A Embossing Machine

A semi-automatic embossing machine equipped with conveyor feed and ejection for both rapid production and operator safety has been developed by Markem Machine Co. Designated Model 79A Embossing Machine, it prints 20-80 objects per minute with either gold or silver leaf, or colors.

The machine is fitted with die blocks on which tradenames, trademarks, or designs are engraved. Small typewheels may be added to imprint size detail, and the printing head may be equipped with self-adjusting die jaws for solid embossing dies, or a slide-in masterplate head to allow interchanging of variables. A lock-up chase for use with individual metal type allows handling of some advertising novelties. Thermostat control assures proper heat in the printing head.

Markem Model 79A Semi-Automatic Embosser

Air operated with a minimum pressure of 35 pounds, Model 79A requires no adjustment for variations in stock thickness. The 550-pound unit measures 21 by 26 inches at the base, and is mounted on a vertical column to a height of 65 inches. Die blocks measure two inches (front to back) by three inches, and are slightly smaller for the modified machine with size wheels.

Readers' Service Item E-2

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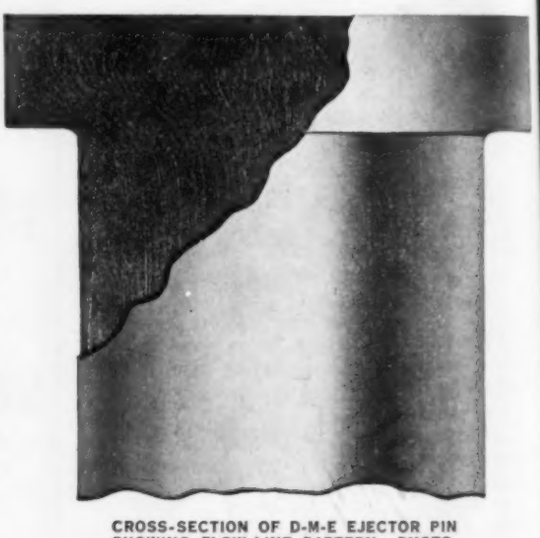

CROSS-SECTION OF D-M-E EJECTOR PIN SHOWING FLOW-LINE PATTERN. PHOTO-MICROGRAPH ENLARGEMENT MADE BY THE DETROIT TESTING LABORATORY.

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LOS ANGELES 7, CAL. 3700 SOUTH MAIN STREET, ADAMS 3-8214

Plastic Film Slitter

A plastic film slitter-rewinder reportedly capable of producing uniform rewind rolls to close tolerances, and at speeds up to 2,500 fpm., has been developed by Slit-Go, Inc. Designated Model 2500, the machine synchronizes the rewind through a servo-loop which regulates speed, tension, and torque.

The center control station provides automatic supervision of the entire operation; start, stop, emergency stop, controlled acceleration and deceleration, variable speeds, threading, slitting pressure, mill roll tension, side shaft and caliper variations, and rewind tensions. Other features include forced lubrication, rapid change-over, snap-on razor blade holders for minimizing set-up time, and fast-acting pillow blocks for easy loading.

Slit-Go Slitter-Rewinder Model 2500

The machine is said to serve a two-fold purpose; single or double rewinding with core contact, or free core rewind. Slit-Go reports that a recent speed test run on 300-gage cellophane resulted in 1,800 finished rolls, 9½-10 inches in diameter, 1¾ inches wide, and averaging 5¼ pounds per roll for a total of 9,450 pounds. Model 2500 is available in two sizes: the 27-inch, which measures 4½ feet wide by 5½ feet long by 4¼ feet high; and the 37-inch, which is 5⅓ feet wide by 5½ feet long by 4¼ inches high. Other specifications are listed as follows:

Threading speed, fpm.	20
Maximum rewind diameter, in.	12
Minimum slitting widths, in.	⅜
Rewind shafts, in.	1.25-3.0

Standard equipment includes two rewind shafts, one mill roll shaft, 50 razor blade holders, and 50 collars. The two models operate on five and 7½ hp variable speed motors, respectively.

Readers' Service Item E-3

Duo-Recording Potentiometer

A new electronic recorder which can record two variables simultaneously on a 12-inch round chart has been introduced by Bristol Co. Designated Dynamaster Potentiometer, the device simplifies com-

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Literature upon request

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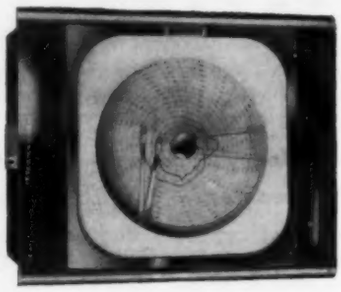
parison between two related measurements with respect to magnitude and time of any deviations from the desired value.

Specific applications of a two-pen recorder include the taking of wet and dry resistance bulb temperatures for humidity, Btu., and temperature differential measurements, and the determining of rotational speed from two different points on a paper machine. Consistency, pressure, weight, and pH variations can also be measured.

The instrument requires no galvanometer, operating electronically at 24-hour, seven-day, and other chart rotation speeds. Hermetically sealed, it requires no maintenance or attention, and can be operated from a mominal 120-volt source. Either 50-60, or 25-cycle frequency can be employed.



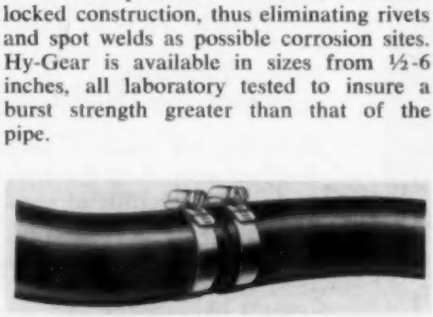
Round chart Dynamaster Recorder

Readers' Service Item E-4

Plastic Pipe Clamp

A stainless steel clamp, reportedly offering complete corrosion resistance, has been marketed by Ideal Corp. for affixing sections of flexible plastic pipe. Called Hy-Gear, the new clamp consists of screw, band, and housing designed for extra clearance in casings and other close quarters.

The clamp is said to feature an interlocked construction, thus eliminating rivets and spot welds as possible corrosion sites. Hy-Gear is available in sizes from ½-6 inches, all laboratory tested to insure a burst strength greater than that of the pipe.

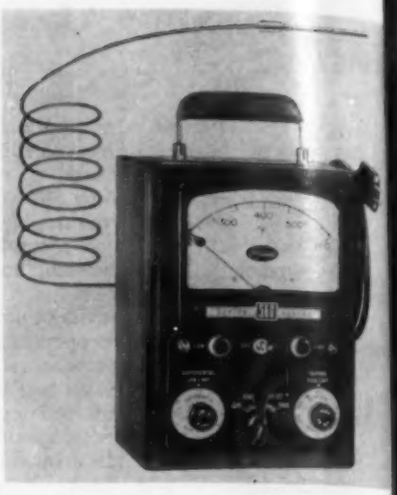


Hy-Gear anti-corrosive clamp

Readers' Service Item E-5

Temperature Controller Series

Four new series of temperature controllers have been added to the line of Thermoswitch devices manufactured by Fenwal, Inc. The instruments reportedly feature adjustable differentials, unusual



Portable Series 560 temperature controller

sensitivity, high load rating, and simplicity of design.

Series 560 uses a thermistor as a heating element, and is designed to operate at 0-600° F. within an accuracy of 0.25% full scale. The control circuit operates independently of the indicating circuit, thus permitting the use of a standard meter for temperature indication. Control accuracy is unaffected by moderate shock or vibration.

The Series 560 can be used either as a straight on-off or as a time-proportioning controller. It operates on 115 volts, 60 cycle AC, and control accuracy is unaffected by line voltages in the range of 95-130. Probe leads up to 200 feet long are possible without change in signal strength or accuracy.

Series 540, a low cost remote indicating temperature controller, is reportedly accurate within 1% of full scale. The unit features a double-pole, double-throw power relay rated for 15 amps, 115 volts integral with the case. Operating on a liquid-filled bulb and capillary system, 540 transmits temperature changes through a bellows assembly to the indicating pointer by means of a simple mechanical linkage. Backlash is eliminated by spring-loading the final lever element.

Series 511 provides a thermostat having both a heavy duty load capacity and small differential. Intended for remote installation, the liquid-filled snap-action thermostat is capable of carrying loads of 20-35 amps without relay where precision temperature response is not vital. The 11-inch bulb has a diameter of approximately 3/16 inch, and is available in two temperature ranges: 50-250° F., and 150-550° F. The control mechanism is housed in a flanged case which can be mounted on any flat surface.

Series 20,000 differs from 511 in that it is intended for direct installation. The local bulb unit is designed to operate over a 50-250° F. temperature range. The thermostat itself consists of a sealed bellows encased in a liquid-filled outer shell, plus a sensitive snap switch in direct linkage. On temperature rise, the liquid expands against the bellows, thus tripping the switch.

Readers' Service Item E-6

New Products

Minute-Mount Frame Assembly

Plastic Picture Frame Strips

Extruded plastic strips of Eastman's Tenite butyrate are available as part of a picture framing assembly introduced by Minute-Mount Corp. Called Minute-Mount, the unit consists of a reversible mount board, a glass, a hanger, and the 16 by 20-inch channeled edging-strips.

Reportedly featuring ease of assembly, the strips fit tightly into scored grooves on the mount board, and are mitered at the corners for firm grip. The strips are extruded by World Plastex.

Readers' Service Item P-1

Phenolic-Housed Soldering Gun

Durez 16840 Black, a new wood flour-filled, nitrile rubber-bearing phenolic is being used by Weller Electric Corp. to mold handle and transformer housings for their redesigned soldering guns. Available in four models, from the 100-watt Junior to the 275-watt D-550, the pistol-type guns are said to feature maximum strength in thin sections around the inserts.

The new material reportedly keeps the overall weight at a minimum, and the combined handle-transformer molding simplifies assembly and cuts production costs. Formerly restricted to professional use, the gun is expected to gain wide acceptance in the "do-it-yourself" field due to its compactness and ease of operation.

Readers' Service Item P-2

Weller Soldering Gun

Koroseal Diaphragm Valve

A diaphragm valve made from rigid Koroseal vinyl resin, and intended for handling slurries, fluids, gases, and corrosive materials at temperatures up to 150° F. and pressures to 150 psi., has been introduced by B. F. Goodrich Co. Industrial Products Division.

The valve reportedly operates as a simple pinch clamp, and is closed by pressing a flexible diaphragm against the raised bottom which is curved to fit. When fully closed, the diaphragm is seated under pressure thus providing a cushioned, leakproof seal. Absence of pockets, corners, grooves, and sharp changes in directional flow make the valve self-cleaning.

The valve does not require packing, according to Goodrich, since the diaphragm seals off the valve stem and working parts from the solutions, thereby eliminating leakage and waste. Special alloys are not required to prevent corrosion of metal working parts due to seepage, and lubricants and other contaminants cannot enter the piping system. The valve is available in sizes from ½-2 inches.

Readers' Service Item P-3

Tri-Laminated Vinyl Fabric

A new type decorator fabric called Filmtex has been introduced by Toscony Fabrics, Inc. It consists of two layers of Krene flexible vinyl film, one colored and/or printed, the other clear, which are laminated to any type of fabric from silk to heavy drill or canvas.

Resistant to wear, water, dirt, soaps, and chemicals, the overlay of clear vinyl gives added protection to the fabric color pattern. The ability to combine any thickness of film to any weight or type fabric is expected to create a new kind of textile with a wide range of usage. Possible new applications include upholstery for outdoor furniture, nursery playpens, and living room couches. Filmtex also provides curtains, draperies, tablecloths, sports goods, and luggage with new dimensions in design. Krene vinyl film is supplied by Bakelite Co., New York, N. Y.

Readers' Service Item P-4

Cross-Sectional View of Open Koroseal Diaphragm Valve

Bi-Seal Anti-Corrosive Tape

A polyethylene-based tape for the protection of conduit joints in locations subject to corrosive fumes has been developed by Bishop Mfg. Corp. Designated Bi-Seal Type 2, the self-bonding tape is said to provide a permanent moistureproof and air-tight sheath.

Reportedly unaffected by acids, alkalies, fumes, gases, steam, or other corrosives, Bi-Seal fuses into a solid insulating mass. Joints of plastic-coated conduit or tubing are stripped at the ends, inserted into a coupling, and wrapped with Bi-Seal using a snug taping tension. Conduits are covered to about an inch beyond the coupling on each side, and thumb-pressed at the end.

Performance specifications are listed as follows:

Thickness, in.	0.20
Elongation, %	350
Shelf life	Unlimited
Maximum operating temperture, °C.	80
Minimum operating temperture, °C.	—40
Water absorption, %	0.0065
Corrosion, visual	None
Chemical resistance, visual	Excellent
Hydrocarbon resistance, visual	Poor
Dielectric constant, 1,000 cycles	2.2
Power factor, 1,000 cycles	0.0006
Dielectric strength, v./mil.	1,000
Volume resistivity, ohm-cm.	10^{15}

Readers' Service Item P-5

Corrosion-Resistant Electrical Tape

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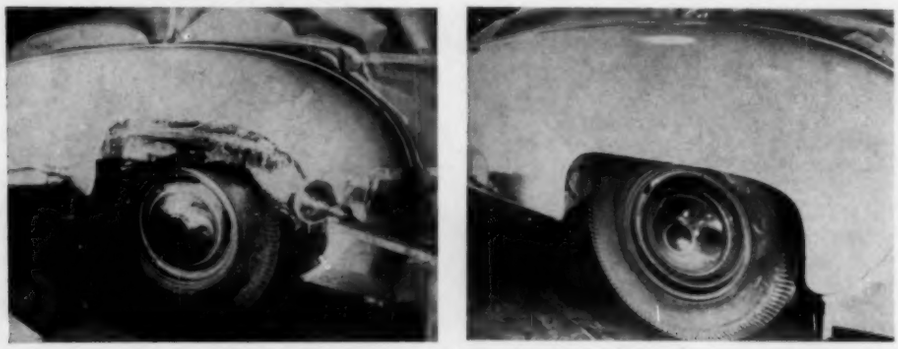
Epoxy-Fiberglass Metal Patch

A new method of patching sheet metal with epoxy resins and fibrous glass cloth has been developed by an automobile manufacturer. Said to save as much as 70% on costs for repairing rusted-out and dented panels, the easy-to-use repair materials are packaged by Arndet-Palmer Laboratories.

Bakelite epoxy resins combined with glass cloth reportedly grip metal surfaces tightly to produce an unusually durable patch. Dust, loose scale, paint, wax, and grease are removed with solvent cleaners and disc sanders, then infra-red heat lamps are used to dry the repair area while the resins are mixed with a hardener. Glass cloth patches saturated with the resin mix are plied up to overlap the area, and heat is again applied to cure the resin. The patch is feathered out with body files and disc sanders, and painted by the usual procedures.

Repairs such as door panels can be made directly on the automobile, since the new method does not involve acetylene welding. The laminate can be drilled and machined to refasten chrome strips, door handles, and other detachable parts. The chemical resistance of the resins is said to enable the repair to withstand weathering, moisture, salt water, and other corroding materials.

Readers' Service Item P-6



Epoxy-Glass Fabric Repair Patching of Auto Panels: (left) Final Curing of Repair Patch; and (right) Finished Repair After Feathering and Repainting.

Five Densities of Felters' Resin-Fiber Material

Synthane Polyester Laminates

Three new grades of thermosetting laminates utilizing DAP, a diallyl phthalate base, have been introduced by Synthane Corp. Reportedly developed for heat and moisture resistance, the laminates are used for electronic devices and precision instruments, with particular emphasis on military components.

The grades are coded according to filler material: Grade C-104, DAP-impregnated canvas; Grade O-104, Orlon; and G-104, woven glass cloth. All are available in sheet and tube form, or as parts fabricated to specifications. Sheet thickness ranges from $\frac{1}{32}$-1 inch in the case of canvas and Orlon. Glass fabric DAP is marketed in sheets $\frac{1}{64}$-1 inch thick.

Tentative specifications, as listed in the company's Engineering Bulletin No. 109, are as follows:

	C-104	O-104	G-104
Flexural strength, min., psi.:			
Lengthwise	19,000	12,000	55,000
Crosswise	12,500	7,500	45,000
Impact strength, min., ft-lbs./in.:			
Lengthwise	1.5	2.0	9.0
Crosswise	1.0	1.5	6.0
Water absorption, %:			
$\frac{1}{16}$-in. sample	1.2	0.45	0.7
$\frac{1}{8}$-in. sample	0.9	0.3	0.5
Specific gravity	1.4	1.2	1.8
Bonding strength, lbs./min.	1,200	800	1,200
Dielectric strength, V.P.M., min., $\frac{1}{16}$-in., short time	350	400	600
Average arc resistance, sec.	120	60	120
Average insulation resistance, megohms	10,000	500,000	250,000
Maximum operating temperature, °F.	275	225	325

Readers' Service Item P-10

Vinyl Coated Simulated Leather

A flexible plastic material, said to combine the workability of vinyl film with the strength of a heavy coated fabric, has been introduced by General Tire & Rubber Co.'s Textileather Division. Designated Nygen Tolex, the material has many of the characteristics of leather hide which reportedly makes it suitable for deep-seat cushion upholstery.

Featuring a special non-woven base for balanced stretch and recovery, Nygen Tolex is said to possess high edge and stitch tear strength, tensile strength, and resistance to flex and fold. Marketed in three standard qualities or weights, the material is available in 21 colors with a simulated leather effect.

Readers' Service Item P-7

Peelable Polyethylene Adhesive

An adhesive for attaching ordinary paper labels to polyethylene containers has been introduced by Rubba, Inc. Designated No. 991 Rubbatex Peelable Adhesive for Polyethylene, it reportedly eliminates the necessity for using special pressure-sensitive labels which must be stripped of their backing prior to application.

The cement has a viscosity of 500 cps., with a total solids content of 55% in an aqueous base. The pH is adjusted to approximately 10.2. Rubbatex-affixed labels can be peeled off with the adhesive adhering only to the paper. The material is available in five-gallon containers, weighing 8.2 pounds to the gallon.

Readers' Service Item P-8

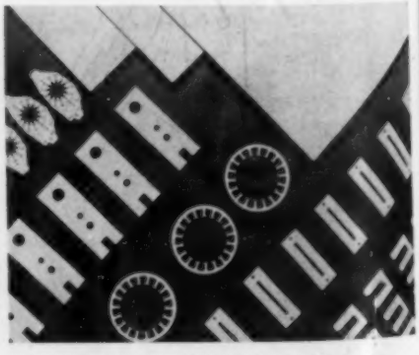
Textile-Resin Filler Material

A non-woven material, consisting of any cardable textile fiber held together with a resin binder, has been introduced by Felters Co. Designated AllFab, the material is said to have proved especially effective as a filler for vinyl coated material in the interior of autos due to its "loft" and susceptibility to electronic stitching.

AllFab, which is licensed to Felters under a patented process, also finds applications as a spacer, a seal against dirt and dust, a shock absorber, a reservoir or wick for grease and oil, and as a wiping material. Fibers of different length, specific gravity, and diameter can be combined and distributed evenly throughout the mass, permitting a range of fiber combinations for specific purposes. Resin binder content can be varied from 5-75%, widening the range of final forms still more.

Material density, which is controlled by resin-to-fiber ratio, may vary from 4-112 ounces per square yard. AllFab is available in thicknesses of $\frac{1}{16}$-2 inches, and in widths of 50-80 inches and multiples of these widths.

Readers' Service Item P-9



Sheet Stock and Fabricated Parts from Synthane's DAP

Book Reviews

"Surface Coatings and Finishes." Philip L. Gordon and George J. Dolgin. Chemical Publishing Co., 212 Fifth Ave., New York, N. Y. Cloth, 5¾ by 9 inches, 299 pages. Price, $9.00.

Standard methods of preparing and using conventional varnish vehicles are briefly reviewed, and the chemical structure, applications, and value of plastic materials used in surface coatings are described in detail. Synthetic resins, fast-drying and water-resistant oils, and specially formulated varnishes are stressed.

Of particular interest to the varnish and protective coatings chemist is the inclusion of numerous tables, graphs, and formulas in the text. Testing methods, including the various types of apparatus used, are also described and illustrated. The appendix contains an alphabetical glossary of resins, their trade names and their manufacturers.

"A French-English Dictionary for Chemists." Second Edition. Austin M. Patterson. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. Cloth, 5½ by 7 inches, 476 pages. Price, $6.50.

This new edition comes more than 30 years after the original volume in 1921. The vocabulary consists of about 42,000 terms, and many terms having the same spelling and meaning in both French and English have been omitted. The book has many new terms from chemistry and the related sciences, and from industry. These terms have been checked against an impressive list of technical dictionaries, and are given in up-to-date nomenclature.

The author has given due consideration to idiomatic phrases, irregular verb forms, and other words that are difficult for the beginner or those whose French has become rusty. The introduction includes a number of notes calculated to facilitate use of the vocabulary. All in all, the new edition should find a welcome place in the reference library of any chemist or chemical engineer.

"Silicones and Their Uses." Rob Roy McGregor. McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. Cloth, 5¾ by 8¾ inches, 302 pages. Price, $6.00.

The history, commercial applications, physiological responses to, industrial cost considerations, and chemistry of silicones are covered in this modest volume which will satisfy the needs of the non-technical, and provide an adequate introduction to the subject for chemists and engineers. Organization of the material is astute and orderly and the text has a conciseness that makes for ready thumbing. The chemical preparation of silicone fluids, compounds, lubricants, resins, rubber, and putty are only cursorily described, but references abound to facilitate further investigation.

"Principles of Emulsion Technology." Paul Becher. Reinhold Publishing Corp., New York, N. Y. Cloth, 4¾ by 7 inches, 149 pages. Price, $2.95.

Written for the technically-trained student of the subject, not for the professional worker in the field, the book covers such aspects of emulsion technology as dispersions and emulsions, surface activity, theory of emulsions, chemistry of emulsifying agents, emulsification equipment, testing of emulsion properties, emulsion formulation, and demulsification. Despite his systematic and well-documented approach to all phases of the subject, the author considers the practical formulation of emulsions as an art instead of a science, a view he neatly carries over into his textual matter, which is well-written and spiced with lively chapter subheads gleaned from Biblical and literary sources.

"Nomography and Empirical Equations." Dale S. Davis. Reinhold Publishing Corp., New York, N. Y. Cloth, 6 by 9½ inches, 236 pages. Price, $6.75.

A valuable addition to the ready reference sources of the working engineer, this book discusses the many engineering applications of empirical equations and nomography and points the way to the use of these principles as durable and practical tools in the solving of perennial calculations. Within the frame of development of empirical equations for two- and three-variable data, new techniques utilizing trigonometric and hyperbolic functions are explained, as well as the modified Gompertz equation, devices for two-variable data, and simple methods for correlating three-variable data. Also covered are the theory and construction of several industrially important types of alignment and line coordinate charts for the rapid correlating of data.

"Conversion Factors and Tables." 2nd Edition. O. T. Zimmerman and Irvin Lavine. Industrial Research Service, Inc., Dover, N. H. Cloth, 4½ by 6¼ inches, 501 pages. Price, $5.00; abroad, $5.50.

Intended as both a time-saver and an eye-saver for the technical worker, and successful on both counts, this convenient and easy-to-read book contains conversion factors on probably all of the known physical constants in use in the United States and throughout the world, as well as arithmetic, engineering, and scientific conversion tables. Export-import firms, too, and manufacturers with foreign commitments, will find the foreign conversion factors of great convenience, for one never knows when he may be called on to convert an Afghanistan kharwar or a Finnish skalpunt to pounds.

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New Literature

"New Color Trends in Plastic Housewares." Monsanto Chemical Co. 6 pages. Cutlery trays and salad bowls were tested for customer color preference, and the results reported and interpreted in this Monsanto report. A check list of overall preferred colors is also included.

Readers' Service Item L-1

"Nitrex 2615." Bulletin 2615. Naugatuck Chemical Division of United States Rubber Co. 4 pages. The properties and processing of Nitrex 2615, a latex that has found application in the fields of textiles, paper coating, non-woven fabrics, adhesives, and tape release coating, are reported here.

Readers' Service Item L-2

"SR-4 Strain Gages Instruments and Accessories." Baldwin-Lima-Hamilton Corp. 11 pages. Price, sketches, and descriptions of the firm's gages and accessories are contained in this latest catalog.

Readers' Service Item L-3

"Antara Catalogue." Antara Chemicals, sales division of General Aniline & Film Corp. 40 pages. The firm's line of detergents, wetting agents, emulsifiers, brighteners, sequestrants, and dyeing assistants are cataloged here.

Readers' Service Item L-4

"Sarco Thermodynamic Steam Traps." Bulletin No. 255-A. Sarco Co., Inc. 4 pages. Specifications of the firm's Type TD thermodynamic steam traps are presented.

Readers' Service Item L-5

"Methylene Chloride, Chloroform, Methyl Chloride, Carbon Tetrachloride." Solvay Process Division, Allied Chemical & Dye Corp. 26 pages. The physical and chemical properties and applications of the firm's chloromethanes are presented in this booklet.

Readers' Service Item L-6

"Roll Surface Finishes." Industrial Rolls Report No. 6. Rodney Hunt Machine Co. 2 pages. The four types of roll surface finishes are described: non-machined, lathe finished, polished or ground, and superfinished.

Readers' Service Item L-7

"Allis-Chalmers Electronic Metal Detector." Bulletin 15B7217B. Allis-Chalmers Mfg. Co., Milwaukee, Wis. 4 pages. This illustrated folder describes and suggests uses of the company's device for electronically detecting impurities in finished goods such as rubber, plastics, textiles, and ceramics.

Readers' Service Item L-8

"IMS Drum Tumblers." Injection Molders Supply Co., Cleveland, O. 4 pages. An illustrated catalog listing the specifications and prices of the company's standard and hexagonal drum tumblers.

Readers' Service Item L-9

"M/41A Controller." Bulletin 5A-13. Foxboro Co., Foxboro, Mass. 12 pages. Specifications, construction, and operating information on the firm's new Model 41A Pneumatic Indicating Controller for the control of process variables such as temperature, pressure, liquid level, and humidity are included here.

Readers' Service Item L-10

"4000 Series Color Paste Concentrates." Bulletin No. 130. Claremont Pigment Dispersion Corp., Brooklyn 11, N. Y. 3 pages. This bulletin lists the properties, prices, and applications of the company's "4000" series pigments.

Readers' Service Item L-11

"Tall Oil for Resins, Part III." Bulletin No. 15. Tall Oil Assn., New York, N. Y. 4 pages. Compounds of tall oil with phenolic resins, styrene resins, vinyl toluene resins, and vinyl esters are discussed in this bulletin. An extensive bibliography is included.

Readers' Service Item L-12

"Sealless Pumps Lick Tough Leakage Problems." Chempump Corp., Philadelphia, Pa. 3 pages. The installation and beneficial operation of the firm's centrifugal pumps at B. F. Goodrich Chemical Co.'s Avon Lake Experimental Station are described.

Readers' Service Item L-13

"Magnetic Ideas from Eriez." B-213. Eriez Mfg. Co., Erie, Pa. 22 pages. Photographs and descriptions of the firm's nonelectrical magnetic equipment are included in this brochure, together with suggested applications.

Readers' Service Item L-14

"Advastab T-72." No. 3355. Advance Solvents & Chemical Corp., New York, N. Y. 2 pages. Specifications, light stability properties, and formulations are included in these data sheets. Advastab T-72 is an organo-tin vinyl stabilizer for use in both rigid and plastisol compounds.

Readers' Service Item L-15

"Atlas Protective Coatings." 7-2 Series Bulletins. Atlas Mineral Products Co., Mertztown, Pa. 12 pages. The selection and use of the Atlas' protective coatings are described. The standard coatings include Neobon neoprene heavy duty; Neelum neoprene extra heavy duty; Zerok 110 styrene copolymer; Zerok 101 plasticized vinyl base; and Nepoxide modified epoxy. Surface preparations are also outlined.

Readers' Service Item L-16

"Prevent Tramp Metal Damage." Form 3R2602. Radio Corporation of America. 1 page. Specifications and a photograph of the RCA Metal Detector for locating tramp metal particles in plastics and textile goods.

"The Intermix." Francis Shaw & Co., Ltd. 19 pages. Photographs and applications of the currently-available Intermix machines for compounding rubbers, plastics, and other materials are contained in this brochure.

Readers' Service Item L-17

"Industrial Batch Ovens." Bulletin 5510. Blue M Electric Co., Blue Island, Ill. 4 pages. Specifications for five of the company's Power-O-Matic electronic furnaces and ovens are given here.

Readers' Service Item L-18

"Atlas Rigid Plastic Structures." Bulletin No. 9-2. Atlas Mineral Products Co. 8 pages. The company's three types of plastic pipe, Ampcoflex, Pee Vee Cee, and Ampcolite, are described in this illustrated bulletin. Tabulations of resistance characteristics and physical properties are also included.

Readers' Service Item L-19

"Polypenco Teflon." Polymer Corp. of Pennsylvania. 8 pages. Electrical, thermal, and mechanical properties; weather, chemical, and moisture resistance; and applications of Du Pont's Teflon are given in this booklet. Polymer Corp. supplies it in rods, tubes, slabs, and tapes in several standard shapes. Polypenco tape is described in detail, and possible design problems are discussed.

Readers' Service Item L-20

"Roll Surface Finishes." Report No. 6. Rodney Hunt Machine Co. 2 pages. The report discusses the various types of instruments used to measure surface roughness such as profilometers and visual scales. Lathe finishing, deburring, polishing, and grinding are also covered.

Readers' Service Item L-21

Abstracts of Important Articles

MATERIALS

"Contribution to the Problem of Plasticizer Migration," K. Zohrer and A. Merz, *Kunststoffe*, 45, 1, 9 (Jan. 1955).

The interaction of surfaces causing migration was studied on a test mix of 60% PVC and 40% DOP against rigid PVC, a rubber cable compound, nitro-cellulose, cellulose hydrate, polyethylene, and leather. In general, migration increases with rising temperatures. Chemical interaction, surface activity, and porosity cause marked migration effects that are directly dependent on temperature. The relation of oil-extraction and migration was confirmed. The limits of plasticizer extraction by nitro-cellulose were investigated, also the effect on migration of roll temperature, milling time, and thickness of foils. The addition of small amounts of various substances, including pigments, silica gel, and active carbon, did not affect migration. (In German).

"Prototypes from Matched Plastics Dies," J. N. Epel, *Modern Plastics*, 32, 7, 113 (March, 1955).

Evaluation samples of reinforced plastics products, equivalent to those made in matched metal molds, are possible with low-cost, matched phenolic dies. Molding pressures of 70-300 psi. can be used with phenolic molds cast at room temperature and given a post-cure at 250° F.

"The Effects of Time, Temperature, and Environment on the Mechanical Properties of Polyester-Glass Laminates," B. B. Pusey and R. H. Carey, *ASTM Bull.*, 204, 54 (Feb. 1955).

The tensile, compressive, and flexural properties of six laminates were tested at temperatures from 23-100° C. for short and long periods of time. Tests were also made in a water environment.

"Measuring Viscosity of Thermosetting Resins by Parallel Plate Plastometry," D. I. Marshall, *ASTM Bull.*, 204, 40 (Feb. 1955).

The parallel plate viscosity test, used to measure viscosity at various temperatures and record viscosity changes during thermal hardening of various types of thermosetting resins, is described in detail, including apparatus used, test theory and procedure, and analysis of results. Resins tested include phenolic, epoxy, urea, and polysiloxane.

"Plasticizer Action," E. Jenckel, *Kunststoffe*, 45, 1, 3 (Jan. 1955).

Plasticizer action is studied by the effect of plasticizer on the solidification temperature of polystyrene, polymethacrylic acid ester, and, for comparison, phenolphthalein. To determine solidifying temperature, it would only be necessary to measure volume. To avoid the difficulties involved in this process, refractive index was used and related to volume. Measurements of refractive index were made on molten and vitreous states over the entire concentration ranges from pure polymer to pure plasticizer. A characteristic volume contraction was found in the vitreous solutions which is proportional to the change in solidification temperature, and which is illustrated by a schematic representation of molecular structure. (In German).

"Mechanical Properties of Polyester-Glass," B. B. Pusey and R. H. Carey, *Modern Plastics*, 32, 7, 139 (March, 1955).

Compressive and flexural strengths of six representative glass-reinforced polyester laminates were reduced more than their tensile strengths when tested at elevated temperatures. Stress-rupture data are also given, using both short- and long-time testing procedures. Water is discussed as a factor affecting long-time stress.

"Parallel Glass Fiber-Reinforced Plastics," James W. Case and J. D. Robinson, *Modern Plastics*, 32, 7, 151 (March, 1955).

Flexural strength of 7-ply parallel glass is compared to that of 181-114 glass cloth and evaluated. Chemical treatments applied to glass fibers are listed along with results of wet strength testing. Fabrication and applications of parallel fiber mats are also described.

"Water Tolerance Values of Vinyl Plasticizers," Philip C. Daidone, *Modern Plastics*, 32, 8, 159 (Apr. 1955).

The order of solvent power for hydrophobic plasticizers in acetone is expressed in terms of specific water values for equal weight comparison or in molar water values for molecular weight comparison. The same order is thought to persist for macromolecules.

"Glass-Fiber Reinforced Polyester Molding Compounds," L. Bajke, *Kunststoffe*, 45, 1, 36 (Jan. 1955).

The properties of the Keripol compounds, their methods of processing, and the production of complicated parts are described. (In German).

"How Cross-Linking Works," E. J. Henley, *Modern Plastics*, 32, 7, 98 (March, 1955).

Physical properties of plastics are dependent on molecular structure. The basic laws of radiation chemistry are stated and production techniques for irradiating plastics to produce cross-linked polymers are described. Tables are included which show the effects of varying doses of radiation on the properties of the end-products. Radiation costs are also discussed.

"Structure and Properties of Ion-Exchange Resins," F. J. Carrasco, *Rev. de Plasticos (Spain)*, 6, 31, 10 (Jan.-Feb. 1955).

From the abundant literature on ion-exchange resins, some fundamental concepts are derived and outlined as they apply to synthetic resins. It is shown that the physical and kinetic properties depend on the characteristics of the three-dimensional polymer linkage, while the chemical properties and exchange capacity are functions of the nature and number of active groups in the exchanger. (In Spanish).

"The Manufacture of Vinylidene Chloride Co-polymers," C. A. Brighton, *Brit. Plastics*, 28, 2, 62 (Feb. 1955).

Proportioning techniques of copolymerization of PVC and vinylidene chloride, with special reference to patents by Dow and N. V. Bataafsche Petroleum Mij. (Holland), are discussed, as well as the effects of various polymerization methods. Also explained are the changes in characteristics as the proportion of vinylidene to PVC is increased; when the copolymer consists mainly of the former, there is evidence of crystallization. A technique is described for determining the molecular weights of copolymers from their intrinsic viscosity in cyclohexanone.

"Recent Experiences in the Manufacture of Polyurethane-Based Foams," F. K. Brochhagen, *Kunststoffe*, 44, 555 (Dec. 1954).

The development of improved apparatus, procedures, and formulations now permits a large measure of variability in the volume density, pore size, and mechanical properties of polyurethane foams. New methods to prevent tear, reduce shrinkage, and increase resistance to humidity and high atmospheric temperature of soft Moltoprene foam are discussed. Mention is made of a new Desmophen (the polyester component used to produce Moltoprene), and new continuous equipment to produce the foamed material in any length desired instead of the previous maximum of two meters. Progress is reported on studies of the behavior of soft Moltoprene under tropical conditions, and the design of an attachment for mechanical metering and mechanical discharge of the reactive mix for the rigid materials. (In German).

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"Composition, Production, and Uses of Urea Foams," R. Klingholz, *Kunststoffe*, 44, 547 (Dec. 1954).

An outline of the various methods for producing plastic foamed materials, followed by a detailed discussion of the process for making the urea foam material known as Iporka. The author suggests that Iporka could be used as a packing material in the same way as phenolic foam in the United States, and it would have the advantages of production from cheaper raw materials, and a lower volumetric weight. (In German).

"The Chemistry of the Production and Processing of the Unsaturated Polyester Resins," A. Muller, *Kunststoffe*, 44, 578 (Dec. 1954).

Following an introductory note on the nomenclature and characteristics of polyesters, a brief outline is presented of the chemical structure of unsaturated polyester resins, the polymerization processes, and the functions of ingredients such as catalysts, activators, etc. (In German).

"Glass Fiber Laminates with Unsaturated Polyester Resins," E. Bock, *Kunststoffe*, 44, 581 (Dec. 1954).

Investigations were carried out to show the relation of glass fibers and polyester resins in regard to the strength characteristics of the reinforced plastic. Curves were obtained for tensile, compression, flex, and impact strengths which revealed definite peaks for an optimum glass fiber content; the height of the peak depending on the quality of the glass fiber. Flex strength was found to increase with low glass fiber content even dipping below that of the pure polyester resin. This effect should be of importance to manufacturers of reinforced resin products. (In German).

"Plasticizers: Treble Output in Twenty Years?" Irving Skeist, *Chem. Week*, 76, 16, 41 (April 16, 1955).

A complete survey of the plasticizer industry, the article traces the history of plasticizer usage up to the present, classifying and describing the characteristics of the more commonly used compounds. A complete tabulation of non-captive plasticizers, their manufacturers, tradenames, prices, specific gravity, and molecular weight is included.

"Fundamentals on the Mechanical and Optical Properties of Plastics," A. Kuske, *Kunststoff-Rundschau*, 2, 1, 3 (Jan. 1955).

The differences in the important mechanical and optical properties of plastics and metals are especially stressed in this review, with the aim of providing a basis for the testing and judging of plastics to determine suitable applications. (In German).

"Polyester Molding Materials," H. Sauer, *Kunststoff-Rundschau*, 2, 1, 1 (Jan. 1955).

A general discussion of polyester resins, their synthesis, and electrical and other properties in comparison with phenolic, urea and melamine plastics. Processing and applications are briefly treated. (In German).

"Polyvinylpyridine Emulsifiers for Polymerization in Acidic Media," James E. Pritchard, Milton H. Opheim, and Patricia H. Moyer, *Ind. Eng. Chem.*, 47, 4, 863 (Apr. 1955).

Vinyl and diene polymers prepared by mass, solution, suspension, or emulsion polymerization present problems in temperature control and/or contamination. In the latter process, special emulsion systems have been designed to reduce polymer contamination, using quaternary salts of polyvinylpyridines as auxiliary emulsifiers. Systems of this type have been found to offer process control, high reaction rates, and product purity in the polymerization of styrene, acrylonitrile, butadiene, and methyl acrylate.

"Plasticization of Polyvinyl Chloride with Alkyl Esters of Pinic Acid," R. F. Coyne and E. A. Yehle, *Ind. Eng. Chem.*, 47, 4, 853 (Apr. 1955).

Pinic acid esters are reported to show average plasticizing efficiency, adequate heat- and light-stability properties, and permanence properties characteristic of monomeric plasticizers. Low temperature flexibility is excellent; however, compatibility properties are rather poor. Evaluation methods are given, and all properties are tabulated.

"Polystyrene Foams," F. Stastny, *Kunststoffe*, 44, 551 (Dec. 1954) Methods of making the American Styrofoam and the German Styropor, and the applications of these foams, are described in detail. (In German).

"Terpene-Derived Plasticizers," Virginia M. Loeblich, Frank C. Magne, and Robert R. Mod, *Ind. Eng. Chem.*, 47, 4, 855 (Apr. 1955).

Oxidation of α-pinene, the main constituent of turpentine, yields dibasic acids which can be used in the preparation of synthetic lubricants and low temperature plasticizers for PVC and polyvinyl acetate stocks. Three esters of pinic acid are found to be especially effective due to the centered position of the cyclobutane ring. The plasticizer screening process is described in detail.

"The Sliding Friction of Teflon," John B. Thompson, George C. Turrell and Bernd W. Sandt, *SPE J.*, 11, 4, 13 (Apr. 1955). The apparatus and method of determining the coefficient of friction for Teflon are explained, and results are tabulated. The coefficient of friction was found to be dependent upon the filler used, since unfilled Teflon gives a constant value of 0.016 at temperatures below 300° C., the flow point at the high normal forces used.

"Sound Velocity in High Polymers," K. Altenburg. *Plaste u. Kautschuk*, 2, 1, 11 (Jan. 1955).

The author concentrates chiefly on the influence of ultra-sound waves on chemical reactions, and the extent to which it is possible to explain the synthesis of high polymers by means of ultra-sound measurements. An equation, based on a general equation for sound propagation in low molecular liquids, is developed, and with certain reservations and provisos could be used to determine degree of polymerization (if less than 100) from the sound velocity. It is added that the equation will have to undergo further testing on high polymers.

"The Formation of Drying-Oil-Modified Alkyd Resins," J. Mleziva, V. and M. Hanzlik, and E. Kadlecek, *Plaste u. Kautschuk*, 1, 12, 275 (Dec. 1954).

Results of a study of the reaction mechanism for the formation of polyesters of phthalic acid and glycerine, modified by drying oils, particularly linseed oil, indicated that at all stages at which the temperature was high enough, polyglycerides were formed which influence both the course of the reaction and the properties of the alkyd resin. Attention is called to the special significance of determining monoglyceride content and hydroxyl number during the reaction. (In German).

"High-Temperature Durability of Laminates," George E. Power, *Modern Plastics*, 32, 8, 139 (Apr. 1955).

A number of laminated materials were tested for flexural strength, weight loss, and perpendicular dielectric strength at temperatures of 125-250° C. for periods up to 32 days. Heat resistance is defined in terms of behavior desired, and other characteristics are presented in tabular form and in three-dimensional graphs.

EQUIPMENT

"Modern Processing Methods on Twin-Screw Machines," A. J. Schaerer, *Kunststoffe*, 44, 601 (Dec. 1954).

The processing of rigid and plasticized PVC, cellulose derivatives, polyethylene and polystyrene on twin screw extruders is discussed. Design, construction, and operating methods of various machines of this type now on the market are described, including the latest Colombo, Pasquetti, Mapre, Trudex and Harburger Eisen & Bronzwerke machines. Included is a summary of present trends. (In German).

"Construction of Molds for Injection Molding Machines," H. Gastrow, *Kunststoffe*, 44, 12, 611 (Dec. 1954).

This description of molds and inclined ejectors for mold parts with shallow undercuts deals specifically with molds for hinged boxes and oblique acting ejectors for releasing the hinge parts. (In German).

"Temperature and Pressure Measurements in the Injection Machine Heating Cylinder," C. E. Beyer, R. B. Dahl, and R. B. McKee, *Modern Plastics*, 32, 8, 127 (Apr. 1955).

The first in a series of three papers deal-

ing with factors affecting the heating cylinder of an injection molding machine, this article describes tests for measuring the plastic temperature and pressure at the nozzle of the heating cylinder. Numerous graphs and equations are included.

PROCESSING

"The Importance and Possibilities of P.V.C. Foams," E. Baschant, *Kunststoffe,* 44, 542 (Dec. 1954).

Following a review of PVC foam development, five newer foaming methods are discussed. These methods include two for soft PVC foam; an American process similar to that for whipped rubber latex foam, and a process using nitrogen gas pressure but no expanding agent. The other three processes are for rigid PVC foams: one using a polyisocyanate; another using an unsaturated compound like organic anhydride, aldehyde, or ketone; and the new Huls process in which AP resin (a ketone resin with a softening point of 75°-80° C.) is added to PVC. Finally, the possible uses of these materials are outlined. (In German).

"Chemical Phenomena During the Processing of Plastics," A. Hoechtlen, *Kunststoffe,* 44, 533 (Dec. 1954).

As the development of plastics continues and manufacturers of plastics raw materials increasingly leave it to the processors to build up macromolecules to suit their individual purposes, the latter find themselves forced to learn more and more about the chemical reactions occurring during processing if they are to avoid costly errors. Hoechtlen discusses some of the most important of these reactions from the standpoint of the processor as they occur with epoxy, phenol and polyester resins, and polyurethanes. (In German).

"Vacuum-Forming of Thermoplastics," F. Escales, *Kunststoffe,* 44, 562 (Dec. 1954).

The principles of the vacuum-forming process, the equipment, materials, and procedure are discussed, together with the advantages and disadvantages of the method as compared with injection molding. (In German).

"Cold Forming of Plastics," F. H. Muller, *Kunststoffe,* 44, 569 (Dec. 1954).

Cold-stretching, as a method of improving the properties of fibers and bristles, is carried out on plastics at temperatures below their softening points. A typical phenomenon in this process is the constriction which separates the stretched from the unstretched portion. First observed on polyamides, the phenomenon is here given a quantitative and a qualitative explanation by analysis of the energy balance of the stress/strain diagram. It is suggested that these results may be applied to cold-forming of plastics in general. (In German).

"Survey of the Methods of Processing Unsaturated Polyester Resins," E. Kuhr, *Kunststoffe,* 44, 607 (Dec. 1954).

Twelve illustrations, chiefly from the German sources, accompany this survey of processing methods for unsaturated polyester resins. (In German).

"Runnerless Injection Molding," Ernest P. Moslo, *SPE J.,* 11, 4, 26 (Apr. 1955).

Several different methods of runnerless molding are discussed: direct injection from a nozzle into a single-cavity mold; direct injection from multiple nozzles into two or more cavities; hot or confined runners to multiple cavities; and production of phonograph records.

"Processing of Epoxy Resins," Vincent Sussman, *Modern Plastics,* 32, 8, 164 (Apr. 1955).

Epoxy resins are defined as polyethers with terminal epoxide groups, usually the reaction products of epichlorhydrin and bisphenol. Hardening reactions involve the use of a complex amine hardener which opens the epoxide groups to form alcohol. Rheological considerations, activation, deaeration, and compounding ingredients are discussed.

"Molding Temperature Control with Temperature Indicating Crayons," M. Marsh, *SPE J.,* 11, 4, 23 (Apr. 1955).

Compression molding, postforming, shell molding, polyethylene coating, and numerous other processes depend upon control and maintenance of a narrow temperature range. Crayons and lacquers of fixed melting points offer a simple, inexpensive method of determining mold or surface temperature.

"Process Capability Analysis," Leonard A. Seder, *SPE J.,* 11, 4, 15 (Apr. 1955).

An evaluation of statistical quality control in terms of increased revenue and lowered costs, this article lists the elements of capability analysis, methods for making such an analysis, and interpretations of the Multi-Vari chart. Dissection by analysis of variance and by the span plan also are discussed.

"Shell Molding for Short-Run Production," Frank K. Shallenberger, *Product Eng.,* 26, 3, 175 (Mar. 1955).

Savings up to 83% can be realized using the shell molding process for short production runs, if parts are properly designed. Applications and guides to minimum piece cost are enumerated. Advantages of the process, such as accuracy, surface finish, detail, machining, tool life, grain structure, and flexibility, are discussed.

APPLICATIONS

"The Properties of Oppanol BA-Sheet, with Special Reference to its Use in Making Buildings and the like Water-Tight," H. Lange, *Plastverarbeiter,* 6, 2, 58 (Feb. 1955).

Oppanol BA is Oppanol 200 (polyisobutylene) intensively milled and compounded with various organic and inorganic ingredients, including very active carbon black. The author discusses the physical and chemical requirements of tightening materials for structures, the properties and processing of Oppanol BA for this purpose, and gives general directions for its use as a jointing and packing material as well as a watertight lining. (In German).

"The Application of Silicones as Materials for Varnishes and Finishes," C. Gundel and J. Roch, *Plaste u. Kautschuk,* 1, 12, 268 (Dec. 1954).

Details of stoving temperatures, times, and properties are followed by descriptions of various tests. Special mention is made of the use of silicone finishes in the baking and candy industries. (In German).

"Plastics in the Graphic Industry," E. Rupp, *Plaste u. Kautschuk,* 2, 1, 4 (Jan. 1955).

The use of plastics in relief printing, cuts, letters, off-set printing, cements for book-binding, and the manufacture of printing ink is discussed, with special reference to the ways in which plastics can replace the non-ferrous metals in the graphic industry. (In German).

"Some Practical Aspects of the Application of Vinylidene-Chloride-containing Polymers," S. Mottram, *Brit. Plastics,* 28, 2, 66 (Feb. 1955).

The PVC-vinylidene copolymers discussed are Geon 202 (containing a small percentage of vinylidene chloride), Geon 205 (containing 20%), Geon 200x20 (representing the peak point of solubility in this range), and Saran fiber (85% vinylidene chloride and 15% PVC). Investigations have shown that Geon 200x20 gives homogeneous blends with natural rubber; which is of particular interest to the cable industry.

GENERAL

"Review of Plastics Developments in 1953-1954," F. J. McGarry, *Mech. Eng.,* 77, 4, 318 (Apr. 1955).

A survey of new materials, fabrication methods, applications, composite materials, protective coatings, and adhesives taken from periodical literature. Citations are numbered and classified in a two-page bibliography.

"What the Plastics Industry Can Learn from the History of Other Materials, as Exemplified by Light Metals," M. Haas, *Kunststoffe,* 44, 12, 588 (Dec. 1954).

Plastics and light metal alloys are constantly finding new applications along parallel lines. Since these materials are in a sense competitive, plastic manufacturers and fabricators would do well to study processing methods, standardization, and specialty training employed in the light metal industry.

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Patent Digest

MATERIALS

Polyethylene-Wax Compositions and Process for Making Same. No. 2,706,719. Raymond G. Newberg, Roselle Park, Howard L. Wilson, Raritan Township, Middlesex County, and Andrew F. Sayko, Westfield, N. J. (to Esso Research & Engineering Co., Linden, N. J.).

Ethylene is polymerized at a temperature above 70° C. and a pressure of 750-30,000 psi., in the presence of a polymerization catalyst and a molten petroleum wax.

Flexible Sheet Material and Method. No. 2,705,690. Harold T. Nelson, Mishawaka, and Raymond A. Pancheri, South Bend, Ind. (to United States Rubber Co., New York, N. Y.).

Flexible sheet material may comprise plasticized vinyl resin with a slip finish layer of resinous polymethyl and polyethyl methacrylates, a vinyl resin, and a silicone in solution.

Compositions Comprising a Polymer of Acrylamide and an Ether. No. 2,706,186. Henry C. Friedlander, Greenwich, and William A. Barber, Stamford, Conn. (to American Cyanamid Co., New York, N. Y.).

The composition consists of a polymerization product containing at least 75% combined acrylamide by weight and a dioxolane or morpholine ether.

Acid Catalyzed Esterification of Cellulose Pretreated with an N,N-Dialkyl Amide. No. 2,705,710. Roe C. Blume, Waynesboro, Va. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

Cellulose is co-mingled with a short chain N,N-dialkyl substituted amide of a lower fatty acid, heated, and esterified in the presence of a lower fatty acid esterifying agent and a strong inorganic acid catalyst.

Method for Preparing Melamine from Dicyanodiamide. No. 2,706,729. Franz Kaess, Trostberg, Ernst Doehlemann, Thalham-Altenmarkt, and Franz Maresch, Trostberg, Germany. (to Sueddeutsch Kaltstickstoff-Werke A. G., Trostberg, Germany).

Dicyanodiamide is placed in a confined space with a mixture of non-reacting gases and ammonia and heated to a temperature not in excess of 300° C. The heating process is stopped before the entire mass of dicyanodiamide reaches the reaction temperature, and the reaction is allowed to spread through the mass from the initially heated part.

Fluorinated Isocyanates and Carbamyl Chlorides. No. 2,706,733. Thomas S. Reid, New Canada Township, Ramsey County, Minn. (to Minnesota Mining & Mfg. Co., St. Paul, Minn.).

Two new series of compounds: 1,1-dihydroperfluoroalkyl isocyanates represented by the formula $C_nF_{2n+1}CH_2N{:}C{:}O$, n having an integer value of 1-12; and $C_nF_{2n+1}CH_2NHCOCl$, with n having the same integer value.

Treatment of Cellulosic Material with Guanamine Resins. No. 2,706,718. James K. Dixon, Riverside, and Norman T. Woodberry, Stamford, Conn. (to American Cyanamid Co., New York, N. Y.).

A non-colloidal condensation product of an aldehyde and a guanamine, in the proportion of 2-20 parts by weight, is added to a regeneratable solution of 100 parts cellulose xanthate and cured to obtain a material of decreased water absorptivity.

Process for Raising the Softening Point of Hydrocarbon Resins. No. 2,705,703. John F. McKay, Jr., Cranford, and Donald F. Koenecke, Elizabeth, N. J. (to Esso Research & Engineering Co., Linden, N. J.).

The process consists of mixing 100 parts resin with at least 5 parts of an oily diolefin hydrocarbon polymer, and heating the mixture to a temperature of 240-280° C.

Polymerization of Perhalocarbons with Trifluorodichloropropionyl Peroxide. No. 2,705,706. Albert L. Dittman, Jersey City, N. J., and John M. Wrightson, Whittier, Calif. (to M. W. Kellogg Co., Jersey City, N. J.).

Trifluorochloroethylene is polymerized at a temperature between −20 and +25° C. in the presence of trifluorodichloropropionyl peroxide as a promoter, maintaining the peroxide concentration at 0.01-0.5% of the trifluorochloroethylene in the reaction mixture.

Silicone Resins Having Phenyl and Methyl Groups Attached to Silicon. No. 2,706,190. Harold A. Clark, Midland, Mich. (to Dow Corning Corp., Midland, Mich.).

A siloxane resin consisting of a monovalent hydrocarbon radical and diorganosiloxane, and having the general formula $R_nSiO_{\frac{4-n}{2}}$

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Price, 25c each.

—The Editor

Production of Resin Coated Particle Material. No. 2,706,188. Chester W. Fitko and John S. Horn, Chicago, Ill.

Sand grains are provided with individual coatings of a solid, non-tacky resin by mixing the grains with normally liquid acid-catalyzed thermoplastic phenol-formaldehyde and hexamethylenetetramine. The mixture is heated and cured to a thermosetting condition; terminating the heating when the resin has advanced to a solid melting in the range from 80-102° C.

Flash Distillation of 2,4-Tolylene Diisocyanate. No. 2,706,169. Theodore R. Beck, Wilmington, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

2,4-tolylene diisocyanate is recovered from the residual tarry mass resulting from its distillation by heating under pressure to 200-300° C., and introducing this superheated mixture into a zone maintained at a pressure substantially lower than the boiling point of the diisocyanate. The purified material is recovered from the vapor phase.

Production of Vinyl Chloride. No. 2,705,732. Frédéric François Albert Braconier, Strivay, and Paulin Rayet, Liége, Belgium. (to Société Belge de l'Azote et des Produits Chimiques du Marly, Liége, Belgium.)

A reaction mixture of acetylene, hydrochloric acid gas, and free chlorine are passed over a nickel chloride catalyst to convert the free chlorine into innocuous chlorinated acetylene, and subsequently forming vinyl chloride by passing the mixture over a mercuric chloride catalyst.

EQUIPMENT

Means for Cutting and Sealing Plastic Bags. No. 2,705,443. Jesse L. Colby, Lockport, N. Y.

The machine consists of a cutter roll with a guide flange for controlling the movement of the cutter arm. This arm carries a means for piercing and cutting the material adjacent to and in advance of each seal, thus forming individual bags.

Method and Tool for Shaping Thermoplastic Materials. No. 2,705,669. Theodore I. Leston, New York, N. Y. (to Eutectic Welding Alloys Corp., Flushing, N. Y.).

A pressure molding apparatus, it includes a material loading chamber and an ejection nozzle in which the inner wall surfaces are amalgamated with a film of mercury having immobile discrete particles forming a bearing surface.

Upwardly Ejecting Injection Machine with Plasticizing Chamber. No. 2,705,343. James Watson Hendry, Bay City, Mich. (to Tube Turns Plastics, Inc., Louisville, Ky.).

The machine comprises a horizontal base member; a ram chamber housing with a mold-receiving, upwardly-directed nozzle is mounted on the base; a vertical ram chamber with movable ram; a pre-plasticizing unit adjacent to and communicating with the ram chamber by means of a side

opening; and a screw for conveying the plastic material. Strain rods positioned about the ram chamber support it. Upper and lower mold platens are also supported by the strain rods.

Heat-Seaming Apparatus for Thermoplastic Sheet Materials. No. 2,705,523. Victor H. Hasselquist, Akron, O. (to B. F. Goodrich Co., New York, N. Y.).

The apparatus comprises a chamber adapted to receive and continuously support thermoplastic material along the inner surface of one wall, a means for pressurizing the chamber so that the material is forced against this wall, and a heating means for fusing preselected portions of the material while under pressure.

PROCESSING

Process for Forming Hollow Articles of Thermoplastic Material and Apparatus for Carrying Out the Process. No. 2,706,308. Friedrich Lorenz, Ludwigshafen, Germany.

The method consists of molding a blank starting piece with a neck finish part and a solid cylindrical part, the diameter of the solid cylindrical part being smaller than that of the hollow article to be formed. The neck finish part and the plastic material constituting the cylindrical part are moved relatively to each other; the plastic material being simultaneously extruded so as to maintain coherence. The extruded plastic material is expanded and positioned between the neck finish part and the solid cylindrical part by applying a fluid pressure medium until the hollow article is finished.

The apparatus consists of a mold cavity and a casing, the upper part of which forms a cylinder projecting coaxially into the cavity of the mold. The cylinder head is tapered to fit snugly against the mold body, and the neck-core is positioned in coaxially. A rod, provided with a head, is positioned outside of and aligned lengthwise with the cylinder, the cavity being completely free for piston action. The piston extrudes the plastic material through an annular nozzle. A channel is bored in the neck-core through which fluid is introduced under pressure into the interior of the hollow article to be formed.

Method of Coloring Cellulose Materials by Hot Embossing. No. 2,705,682. Karl Wille, Somerville, N. J. (to American Cyanamid Co., New York, N. Y.).

Dual color effects can be obtained on cellulosics by hot embossing, which comprises applying an emulsion to one of the surfaces. The internal phase of said emulsion being a water-insoluble wax with a melting point of 140-270° F., and the external phase being an aqueous dispersion of a water-insoluble pigment and an oil-soluble color. The coating is dried at a temperature below the melting point of the wax, and the coated material is passed under an embossing roll heated to the temperature at which the wax melts. The contrasting color effect is obtained by the dissolving of the oil-soluble color in the molten wax.

Process for Preparing Foamed Structures. No. 2,706,311. Jack R. Durst, Columbus, and Henry A. Pace, Akron, O. (to Goodyear Tire & Rubber Corp., Akron, O.).

Gas-evolving foamable resinous material is frozen and placed within an interstice. The temperature is then raised to cause foaming.

Method of Working Plastic. No. 2,705,346. Raymond M. Schlabach, Hills and Dales, Canton, and Louis V. Bockius, Congress Lake, O.

The method of rotatably attaching a plastic bar to a wall member includes forming a longitudinally-bowed bar-like plastic article with an integral laterally-extending tapered shank portion, and inserting it into a circular opening in the wall member. Heat and axial pressure are applied to the shank portion to produce a button-head shape of larger diameter than the opening, the length being simultaneously reduced.

Process for Finishing Organic Thermoplastic Sheeting. No. 2,706,310. Leopold Eckler, Summit, and William P. Moeller, Orange, N. J. (to Celanese Corp. of America, New York, N. Y.).

An organic acid ester of cellulose sheeting with surface blemishes is pressed between unheated rotatable surfaces at a pressure of at least 2,000 psi., whereby the appearance and uniformity of sheeting gage are improved.

Method for Printing on the Surface of Polyethylene Plastics. No. 2,704,382. Werner H. Kreidl, New York, N. Y.

Polyethylene is subjected to differential heat treatment whereby the printed surface is sufficiently heated to improve its bonding properties without altering resin stability, and the material adjoining the surface layer is held at temperatures below those required for bond stability.

Process for Making Fluorocarbon Derivatives. No. 2,704,776. James D. La Zerte, St. Paul, Wilbur H. Pearlson, Bald Eagle, and Edward A. Kauck, St. Paul, Minn. (to Minnesota Mining & Mfg. Co., St. Paul, Minn.)

Fluorocarbon bromides are produced by heating R_fCBrO to decomposition temperatures; f representing a perfluorocarbon radical.

Method and Apparatus for Casting Vinyl Film Continuously. No. 2,704,735. William D. Hedges and John C. Lowman, Franklin County, O. (to Columbus Coated Fabrics Corp., Columbus, O.)

Casting supports comprise a belt with a textile base, a rubber coating, a resinous coating, and an outer coating of polyvinyl alcohol. The strippable composite base is produced by coating the uncured rubber with polyvinyl acetate and alkyd resin, and applying the alcohol when the resinous coat has dried.

Process for the Preparation of Low Molecular Weight Polymers of Vinyl Acetate. No. 2,704,753. Leo J. Monaghan, Springfield, Mass. (to Shawinigan Resins Corp., Springfield, Mass.)

Polyvinyl acetate with a viscosity of 1-3 cps. is produced by heating and agitating the following components under reflux: 100 parts vinyl acetate monomer; 0.02-1 part hydrogen peroxide; a water-soluble alkali metal salt of an organic carboxylic acid; 4 parts water; and 20-180 parts of an organic solvent for polyvinyl acetate. The solvent should be essentially a ketone of the general formula $RCOR_1$, where the Rs represent alkyl groups containing 1-7 carbon atoms. The solvent is distilled when monomer conversion reaches the desired point.

Heat Stabilization of Polyamides. No. 2,705,227. Gelu Stoeff Stamatoff, Newark, Del. (to E. I. du Pont de Nemours & Co., Ltd., Wilmington, Del.)

Synthetic linear polycarbonamides having recurring intralinear carbonamide groups as an integral part of the main polymer chain, are stabilized against the degradative effects of heat, oxygen, and atmospheric conditions by the addition of 0.001-0.03% by weight of dissolved copper and no more than 5% by weight of a sodium, potassium, ammonium, or magnesium halide.

Production of Vinyl Chloride Polymers. No. 2,705,226. Alexander Edward Bond, New Malden, England. (to Imperial Chemical Industries, Ltd., London, England.)

Polyvinyl alcohol is partially esterified with acetic and a polybasic acid; the latter containing two adjacent carboxyl groups, no more than one hydroxyl group, and being of cis formation when unsaturated. Vinyl chloride is dispersed by agitation in an aqueous solution containing alkali metal and ammonium salts of the alcohol, and polymerized.

APPLICATIONS

Fluid Conducting Plastic Impregnated Tubing. No. 2,706,497. Samuel M. Shobert, Mishawaka, Ind.

The conduit consists of a tubular porous cardboard matrix which is impregnated with a cross-linked thermosetting resin. This resin comprises 40-80 parts alkyd prepared by the interaction of approximately stoichiometric amounts of an alkylene glycol, an unsaturated polybasic acid, and a polymeric ester of allyl alcohol and unsaturated polybasic acid.

Flexible Plastic Tubing. No. 2,704,556. Matthew B. Blish, Oak Park, Ill.

The plastic wall of the tubing contains a plurality of metallic flexible strips extending longitudinally at uniformly spaced intervals. These strips act as a means of support against inward collapse on bending, and thereby provide an unrestricted passage through the tube.

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Domestic Production and Sales of Plastics and Resin Material, 1954 Totals and January, 1955

Following are the preliminary 1954 totals and the estimated January, 1955 statistics for domestic production and sale of plastics and resinous materials. Units listed are in pounds, dry basis, unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily restricted to the protective coating industry. Totals for 1953 are not available for comparison with the preliminary 1954 figures; however, January production and sales of phenolics show an increase of approximately 5% over November and December. Vinyls were in still greater demand, increasing 8% over previous months.

	Preliminary Total, 1954		January, 1955	
	Production	Sales	Production	Sales
Cellulose Plastics:[1]				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	17,784,894	17,525,548	1,520,519	1,420,649
Sheets, 0.003 gage and over	12,239,469	12,398,677	1,201,385	1,060,458
All other sheets, rods, and tubes	5,809,074	5,343,096	567,948	481,372
Molding and extrusion materials	76,562,500	75,548,025	6,907,671	6,867,887
Nitrocellulose sheets, rods, and tubes	5,266,376	4,908,530	414,134	454,283
Other cellulose plastics	5,561,631	5,005,288	552,980	474,252
TOTAL	123,223,994	120,729,164	11,164,637	10,758,901
Phenolic and Other Tar-Acid Resins:				
Molding materials[1]	177,564,493	186,416,848	16,439,889	16,063,782
Bonding and adhesive resins for—				
Laminating (except plywood)	63,203,449	43,322,406	5,309,181	3,988,697
Coated and bonded abrasives	10,161,863	11,031,993	979,042	1,189,855
Friction materials (brake linings, clutch facings, and similar materials)	15,689,496	14,805,749	1,547,884	1,477,037
Thermal insulation (fiber glass, rock wool)	34,920,323	36,362,516	2,801,052	2,987,473
Plywood	29,778,958	28,484,599	3,346,946	2,980,777
All other bonding and adhesive uses	13,044,105	12,936,282	1,138,545	1,249,081
Protective-coating resins, unmodified and modified except by rosin	23,621,802	20,831,057	1,988,229	1,963,151
Resins for all other uses	27,996,089	25,021,016	2,817,422	2,552,087
TOTAL	395,980,578	379,212,466	36,368,190	34,519,940
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	35,880,236	34,212,863	3,800,099	3,528,808
Paper-treating and paper-coating resins	20,071,385	18,998,425	1,542,748	1,485,564
Bonding and adhesive resins for—				
Plywood	77,395,796	73,224,261	6,916,303	6,430,586
All other bonding and adhesive uses, including laminating	25,276,350	23,804,433	2,344,034	2,317,204
Protective-coating resins, straight and modified	27,950,285	21,387,368	2,813,410	2,236,671
Resins for all other uses, including molding	66,781,547	64,423,018	6,094,572	5,894,180
TOTAL	253,355,599	236,050,368	23,511,166	21,893,013
Styrene Resins:				
Molding materials[1]	325,105,367	309,378,418	30,952,840	28,537,419
Protective-coating resins, straight and modified	85,519,069	81,734,791	8,074,018	7,494,957
Resins for all other uses	90,335,161	84,041,811	5,906,750	5,587,227
TOTAL	500,959,597	485,155,020	44,933,608	41,619,603
Vinyl and Vinyl Chloride Resins:[2]				
Polyvinyl chloride and copolymer resins (50% or more polyvinyl chloride) for—				
Film (resin content)		69,942,539		6,290,815
Sheeting (resin content)		56,587,805		4,454,684
Molding and extrusion (resin content)		147,284,047		15,441,360
Textile and paper treating and coating (resin content)[3]		49,545,639		4,512,353
Flooring (resin content)		34,889,532		4,340,504
Protective coatings (resin content)		23,676,213		2,287,582
All other uses (resin content)		35,147,920		3,600,105
All other vinyl resins for—				
Adhesives (resin content)		26,609,447		3,103,387
All other uses (resin content)		74,090,204		7,189,967
TOTAL	516,756,007	517,773,346	53,806,385	51,220,757
Coumarone-Indene and Petroleum Polymer Resins	202,894,474	203,146,166	18,323,510	18,404,461
Miscellaneous Synthetic Plastics and Resin Materials:				
Molding materials[1,4]	203,921,698	173,846,696	22,870,752	17,545,816
Protective-coating resins[5]	6,848,623	3,688,546	384,888	221,038
Resins for all other uses[6]	125,480,799	133,255,185	13,147,007	15,593,635
TOTAL	336,251,120	310,790,427	36,402,647	33,360,489
GRAND TOTALS	2,329,421,369	2,252,856,957	211,777,164	224,510,143

[1]Includes fillers, plasticizers, and extenders.
[2]Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3]Includes data for spreader and calendering-type resins.
[4]Includes data for acrylic, polyethylene, nylon, and other molding materials.
[5]Includes data for epichlorohydrin, acrylic, polyester, silicone, and other protective-coating resins.
[6]Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.
SOURCE: United States Tariff Commission, Chemical Division.

Current Market Prices

Price Changes and Additions

Adhesives

Polyester Foam Cement PC-232	gal.	$2.40 /	$2.90
Plastic Cement	gal.	2.25 /	2.70
Vac 110	lb.	.205 /	.225
115	lb.	.27 /	.29
180	lb.	.095 /	.12
185	lb.	.1725 /	.2275
186	lb.	.0875 /	.1125
192	lb.	.07	

Catalysts

Cadet benzoyl peroxide, granules	lb.	.98 /	2.00
Paste	lb.	.95 /	2.25
Powder	lb.	1.50 /	2.37
Dichlorobenzoyl peroxide	lb.	3.00 /	4.25
Lauroyl peroxide	lb.	1.90 /	3.50
Methyl ethyl ketone peroxide	lb.	1.85 /	4.00
MN 551	lb.	.95 /	1.40
901	lb.	.36 /	.80
951 Ciba	lb.	.82 /	1.32

Coating Resins

Polyfluoron liquid dispersions	lb.	2.65 /	3.85
Paste dispersions	lb.	4.20 /	4.40
Primer 140	qt.	7.88 /	8.25

Colors

Cyanamid blues	lb.	5.15 /	6.10
Greens	lb.	4.90 /	6.20
Rhodamines	lb.	6.15	
Violets	lb.	4.00	
Laminac color pastes	lb.	.76 /	1.90
Mapico blacks	lb.	.135	
Browns	lb.	.145	
Tans	lb.	.21	
Yellows	lb.	.1125 /	.1175
Plastics Color, blacks	unit	.75 /	1.40
Blues	unit	.65 /	1.10
Brown	unit	1.20	
Greens	unit	.65 /	1.00
Reds	unit	.65 /	2.50
Whites	unit	.80 /	1.30
Yellows	unit	1.15 /	1.55

Fillers

Hydrite	ton	22.50	
Flat	ton	22.50	
PD-10	ton	46.50	

Lubricant

Sprits	lb.	1.00 /	1.25

Molding Compounds & Resins

Cellulosic

Lumarith molding cmpds., Group III	lb.	.36 /	.45

Epoxy

Araldite 502, 6010, 6020	lb.	.80 /	.995
504	lb.	.77 /	.965
551, 6060	lb.	.75 /	.95
6030, 6040	lb.	.885 /	.995

Fluorocarbon

Polyfluoron, high density crystals & pellets	lb.	9.00 /	9.50
Colors	lb.	9.50 /	10.00
Low density powder	lb.	8.50 /	9.00
Dispersion grade	lb.	10.50 /	11.00

Polyamide

G.M.I. Polyamide 115	lb.	1.13 /	1.33

Polyester

Laminac 4146	lb.	.43 /	.445
Mylar, rolls, types A & C	lb.	2.50 /	4.80
Type D	lb.	3.00 /	3.30
Sheets, type A	M. sq. in.	.09 /	1.11
Type C	M. sq. in.	.09 /	.15
Type D	M. sq. in.	.53 /	1.34

Styrenes

Kralastic, std. colors	lb.	.50 /	1.10

Vinyls

Goodrich PVC Plastisols (dry wt.)	lb.	.38 /	.72

Plasticizers

Adipol 2EH, 10A, 810, XX	lb.	.425 /	.455
ODV	lb.	.47 /	.50
Dinopol 235	lb.	.345 /	.375
Ethox	lb.	.50 /	.525
Flexol 3GH	lb.	.44 /	.46
3G0	lb.	.53 /	.55
4G0	lb.	.325 /	.355
8N8	lb.	.355 /	.395
10-10, 810, CC-55, DOP	lb.	.305 /	.335
77-G, 426	lb.	.27 /	.31
A-26	lb.	.425 /	.455
B-400	lb.	.25 /	.29
R2H	lb.	.59 /	.595
T0F	lb.	.435 /	.475
Harflex 10	lb.	1.25 /	1.27
40	lb.	.66 /	.68
50, 80	lb.	.61 /	.63
60	lb.	.62 /	.64
90	lb.	.88 /	.90
120, 150	lb.	.305 /	.335
140, 160	lb.	.30 /	.33
180	lb.	.295 /	.325
220	lb.	.435 /	.465
260	lb.	.42 /	.45
280	lb.	.43 /	.46
300	lb.	.63 /	.66
500	lb.	.315 /	.345
Butyl stearate	lb.	.23 /	.26
Monsanto dibutyl phthalate	lb.	.30 /	.33
Diethyl phthalate	lb.	.25 /	.28
Dimethyl phthalate	lb.	.275 /	.305
Diphenyl phthalate	lb.	.5175 /	.5375
DIDA, DOA	lb.	.425 /	.455
DIDP, DIOP, DOP	lb.	.305 /	.335
HB-20	lb.	.15 /	.17
HB-40	lb.	.22 /	.24
Orthonitrobiphenyl	lb.	.13 /	.15
Tricresyl phosphate	lb.	.33 /	.36
Triphenyl phosphate	lb.	.39 /	.40
Ohio-Apex dibutyl phthalate	lb.	.30 /	.33
Plasticizer 1	lb.	1.17 /	1.37
Santicizer 1-H	lb.	.50 /	.51
3	lb.	.46 /	.47
8	lb.	.43 /	.44
9	lb.	.39 /	.42
140	lb.	.33 /	.36
141	lb.	.34 /	.37
160	lb.	.25 /	.28
601	lb.	.32	
602	lb.	.305	
B-16	lb.	.4875 /	.4975
E-15	lb.	.5075 /	.5375
M-17	lb.	.4275 /	.4575

Stabilizers

Advastab 48-79	lb.	.85 /	.95
50-LT	lb.	3.20 /	3.35
X23-74	lb.	.70 /	.80
X30-15	lb.	.65 /	.75

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CALENDAR of COMING EVENTS

May 20
SPE Buffalo Section, Park Lane Restaurant, Buffalo, N. Y.

May 24
SPE Philadelphia Section, Benjamin Franklin Institute, Philadelphia, Pa.

May 25
Reinforced Plastics Group, SPE New York Section, Tufaro's Restaurant, Corona, N. Y. SPE Quebec Section, Queens Hotel, Montreal, Que., Canada.

May 26
SPE Newark Section, Annual Outing, Mazda Brook Farms, Parsippany, N. J.

May 31-June 3
Design Engineering Show, Convention Hall, Philadelphia, Pa.

June 7
SPE Southern California Section, Scully's Restaurant, Los Angeles, Calif.

June 8
SPE Western New England Section, Annual Outing, Wamponoag Country Club, West Hartford, Conn.

June 10
Fort Wayne Rubber & Plastics Group, Annual Outing.

June 10
SPE Cleveland-Akron Section, Annual Outing, Columbia Hills Course.

June 15
SPE New York Section, Gotham Hotel, New York City.

June 17
SPE Miami Valley Section, Annual Outing, Hartwell Country Club, Cincinnati, Ohio.

June 24
Detroit Rubber & Plastics, Annual Outing.

June 29
Reinforced Plastics Group, SPE New York Section, Tufaro's Restaurant, Corona, N. Y.

June 29—July 1
ASTM Committee D-20 on Plastics, Chalfonte-Haddon Hall, Atlantic City, N. J.

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News of the Industry (Cont'd. from p. 24)

Hooker Celebrates Fifty Years —Merger with Durez Official

On May 5, 1905, ground was broken for Hooker Electrochemical Co.'s original plant in Niagara Falls, N. Y. Diversification from the company's two original products, caustic soda and chlorine, established the firm in the chemical field, and subsequent expansion has seen the opening of two new plants at Tacoma, Wash., and Montague, Mich. Hooker, celebrating its 50th anniversary, now supplies over 100 different chemicals to more than 30 industries.

Employing almost 2,500 people, Hooker sales reportedly run about $45 million per year. The company has allotted a research budget of over $1 million for 1955 as part of its diversified expansion plans. To strengthen the company's position in the rapidly growing plastics field, Hooker directors voted overwhelmingly for incorporation of Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y.

The proposal was authorized by a vote showing 79.9% of the outstanding preferred stock, and 92.19% of the common stock in favor. The merger was also favored by 93.58% of the holders of Durez common stock.

A certificate of consolidation was filed on April 29, and three representatives from the Durez board of directors were chosen to join the eight-man Hooker board. The newly consolidated board will consist of the following members: E. R. Bartlett, chairman; J. H. Babcock, E. L. Burnham, H. M. Dent, R. W. Hooker, B. Klaussen, C. S. Lutkins, J. P. Marquand, R. L. Murray, C. N. Osborne, and J. F. Snyder.

At the first meeting of the combined board, John F. Snyder, former vice president-secretary and a director of Durez, was elected a vice president of Hooker. The board also announced the following appointments: Alfred W. Hanmer, Jr., vice president of Durez Plastics Division in charge of sales; Walter H. Prahl, vice president in charge of research and development for the division; and Edward W. Mathias, treasurer for the Durez Division.

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